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Adipic Acid-Enhanced Lime and Limestone Testing at the EPA Alkali Scrubbing Test Facility. Volume 2: Appendices

Bechtel Corp.
San Francisco, CA

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

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ADIPIC ACID-ENHANCED LIME AND LIMESTONE TESTING AT THE EPA ALKALI SCRUBBING TEST FACILITY
-FINAL REPORT-

VOLUME 2. APPENDICES

July 1981

By

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16. ABSTRACT The report gives results of an advanced test program on a prototype lime/limestone wet-scrubbing test facility for removing SO2 and particulates from coal-fired boiler flue gases. Major effort during the tests was concentrated on evaluating adipic acid as an additive for enhancing SO2 removal efficiency. Results show that adipic acid can substantially improve the performance of limestone spray towers or turbulent contacting absorbers. SO2 removals > 90% and reliable scrubber operation were demonstrated in four long-term (> 1 month) limestone runs. The optimum pH was determined to be about 5.1 with the additive, compared to 5.5-6.0 without. Because of the lower operating pH, limestone utilization was significantly improved, and tests showed lower limestone consumption and reduced waste solids production with the additive. Consequently, both capital and operating costs for an adipic acid enhanced limestone system are estimated to be 5% lower than for a conventional system. The improved limestone utilization also contributes to reliable scrubber operation, thus reducing maintenance costs. Mathematical models were derived which correlate the SO2 removal performance as a function of operating parameters such as gas and slurry flow rate, pH, and adipic acid concentration.

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Pollution	Scrubbers	Pollution Control	13B	13I
Adipic Acid	Calcium Oxides	Stationary Sources	07C	07B
Flue Gases	Calcium Carbonates	Particulate	21B	
Desulfurization	Coal		07A,07D	21D
Dust	Boilers		11G	13A
Aerosols	pH			
Mathematical Models			12A	

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APPENDIX A

CONVERTING UNITS OF MEASURE

APPENDIX A

CONVERTING UNITS OF MEASURE

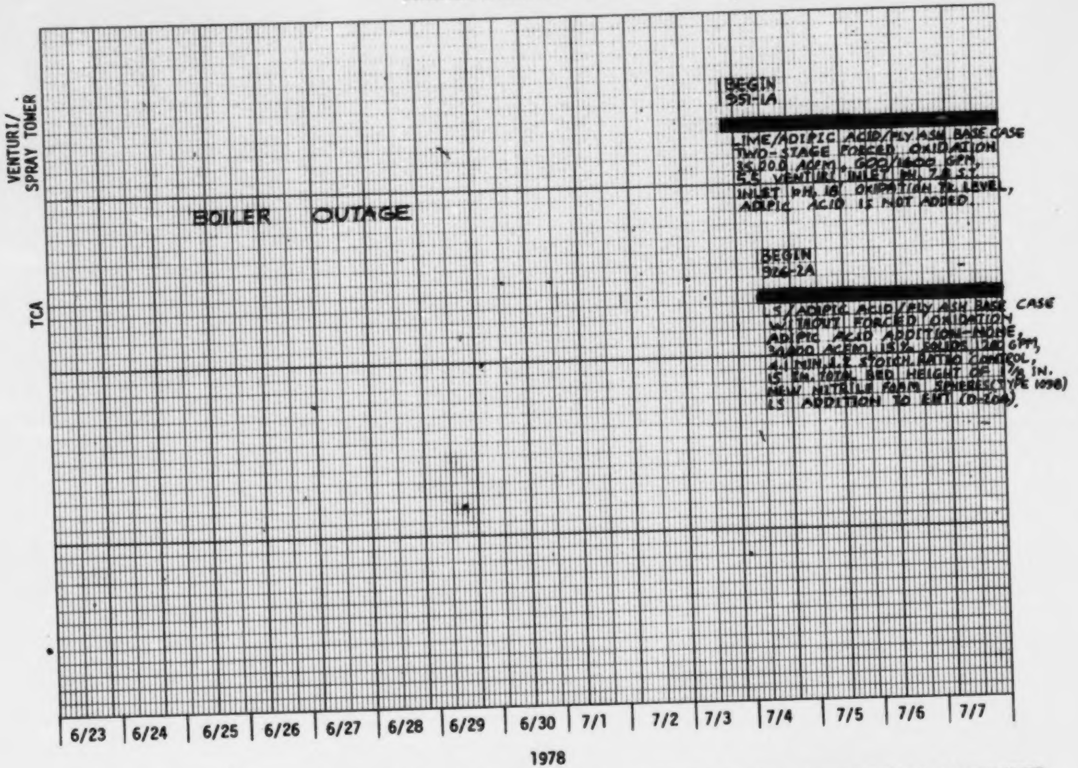
Environmental Protection Agency policy is to express all measurements in Agency documents in metric units. In this report, however, to avoid undue cost and for consistency with previous reports on the Shawnee test results, English units are used throughout. Conversion factors from English to metric units are given below:

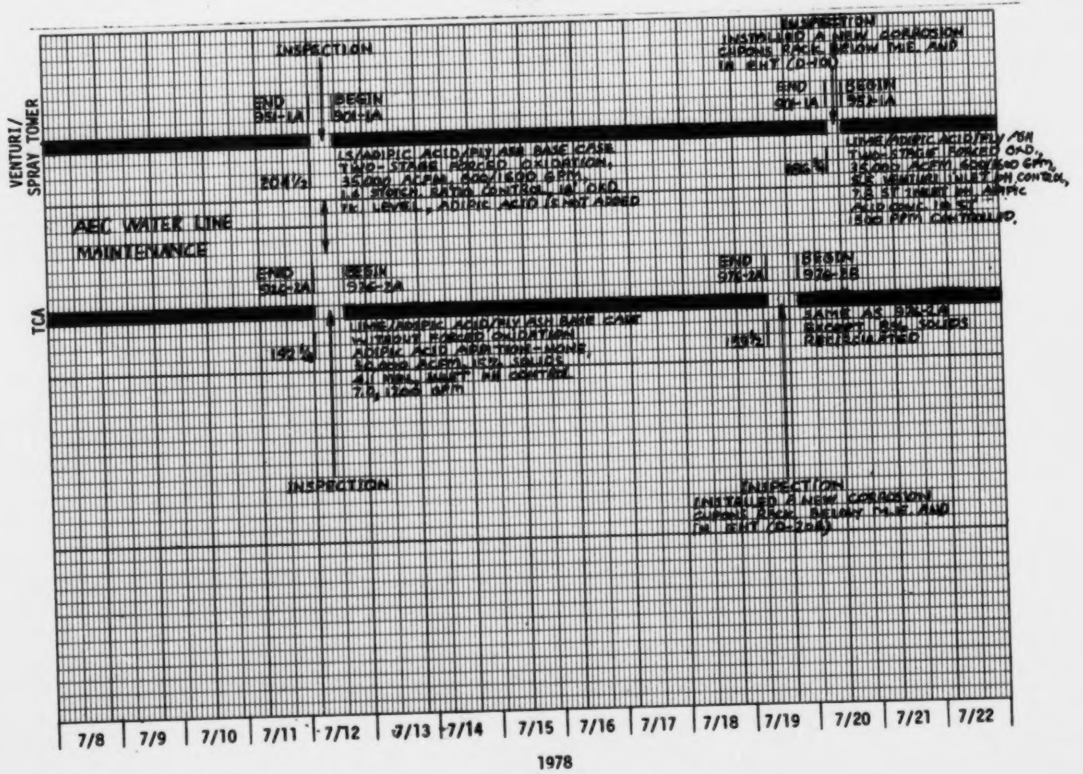
To Convert From	To	Multiply By
scfm (60°F)	nm^3/hr (0°C)	1.61
cfm	m^3/hr	1.70
°F	°C	(°F-32)/1.8
ft	m	0.305
ft/hr	m/hr	0.305
ft/sec	m/sec	0.305
ft^2	m^2	0.0929
ft^2/tons per day	m^2/metric tons per day	0.102
gal/mcf	l/m^3	0.134
gpm	l/min	3.79
gpm/ft^2	$l/min/m^2$	40.8
gr/scf	g/m^3	2.29
in.	cm	2.54
in. H_2O	mm Hg	1.87
lb	g	454
lb-moles	g-moles	454
lb-moles/hr	g-moles/min	7.56
lb-moles/hr ft^2	g-moles/min/m^2	81.4
lb-moles/min	g-moles/sec	7.56
psi	kPa	6.895

APPENDIX B

SCRUBBER OPERATING PERIODS

SCRUBBER OPERATING PERIODS





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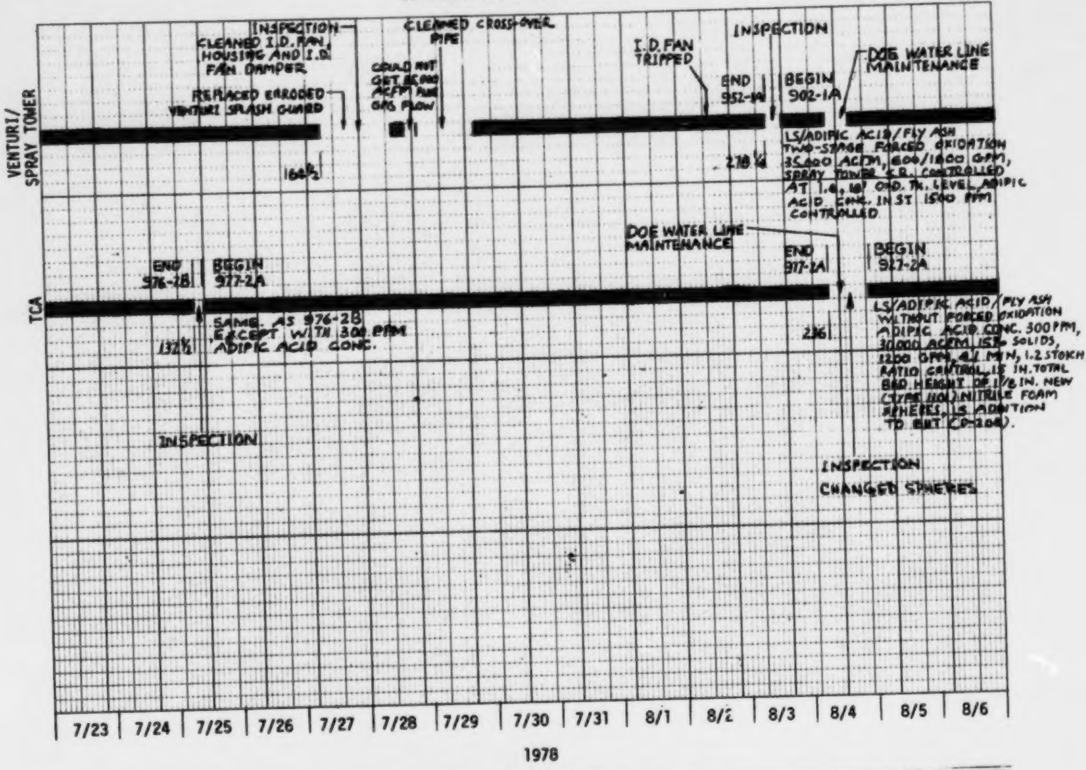

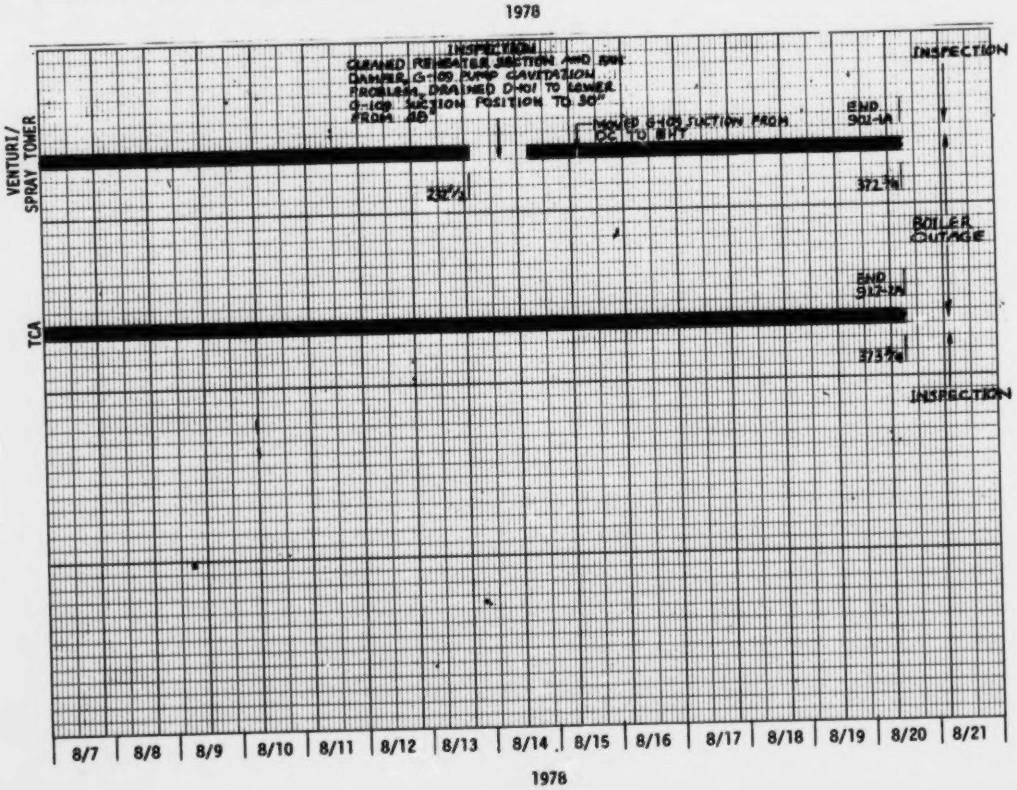

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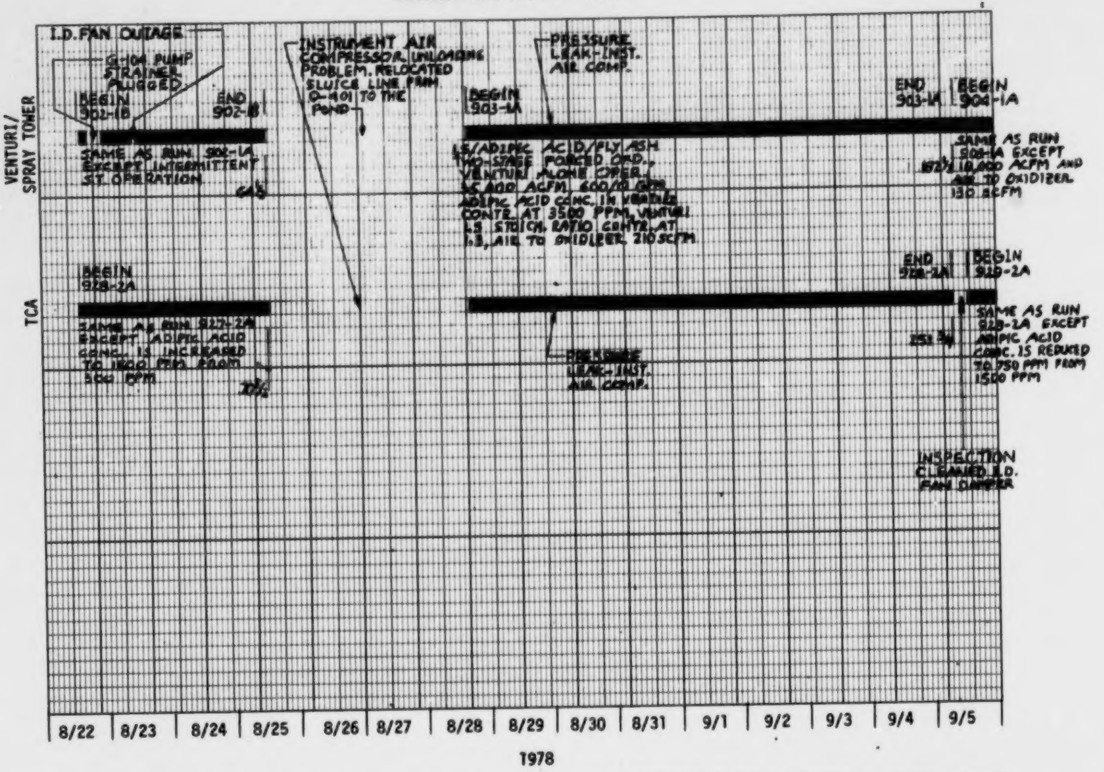

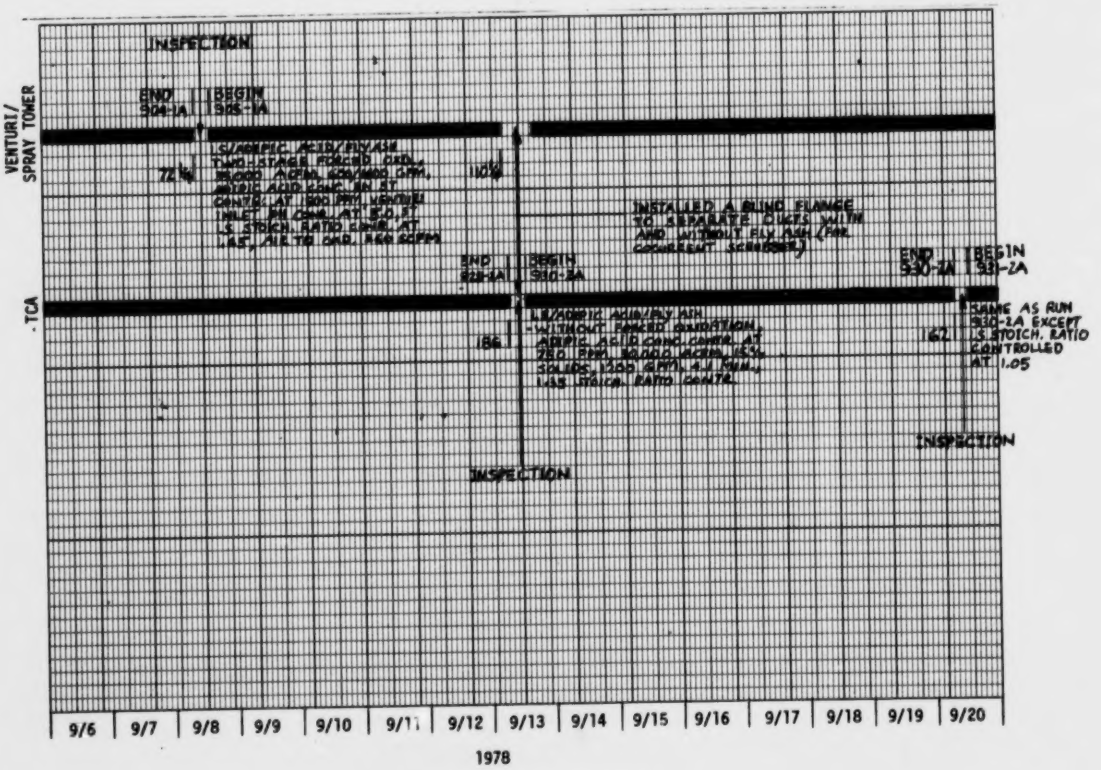

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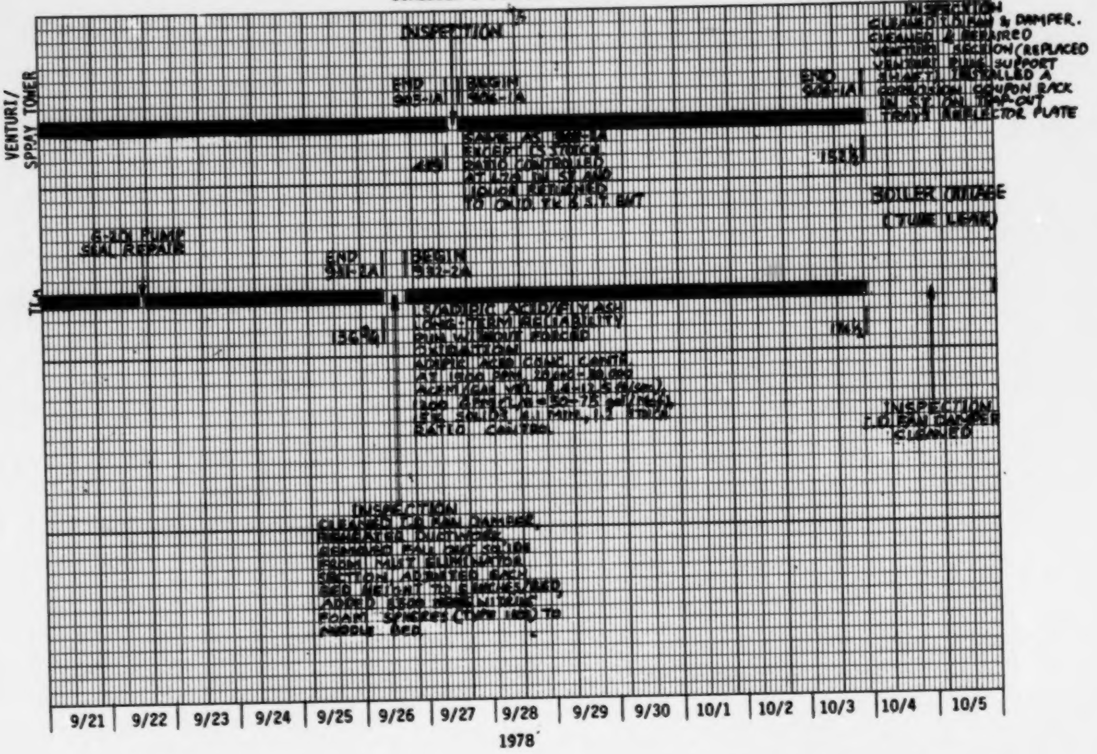

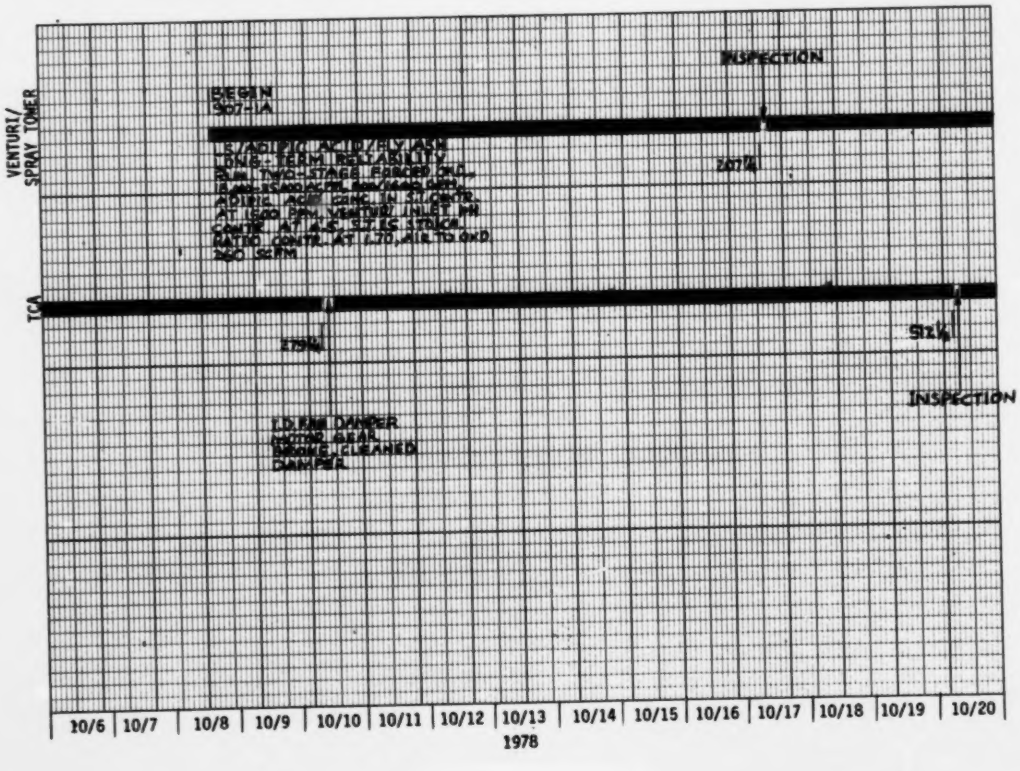

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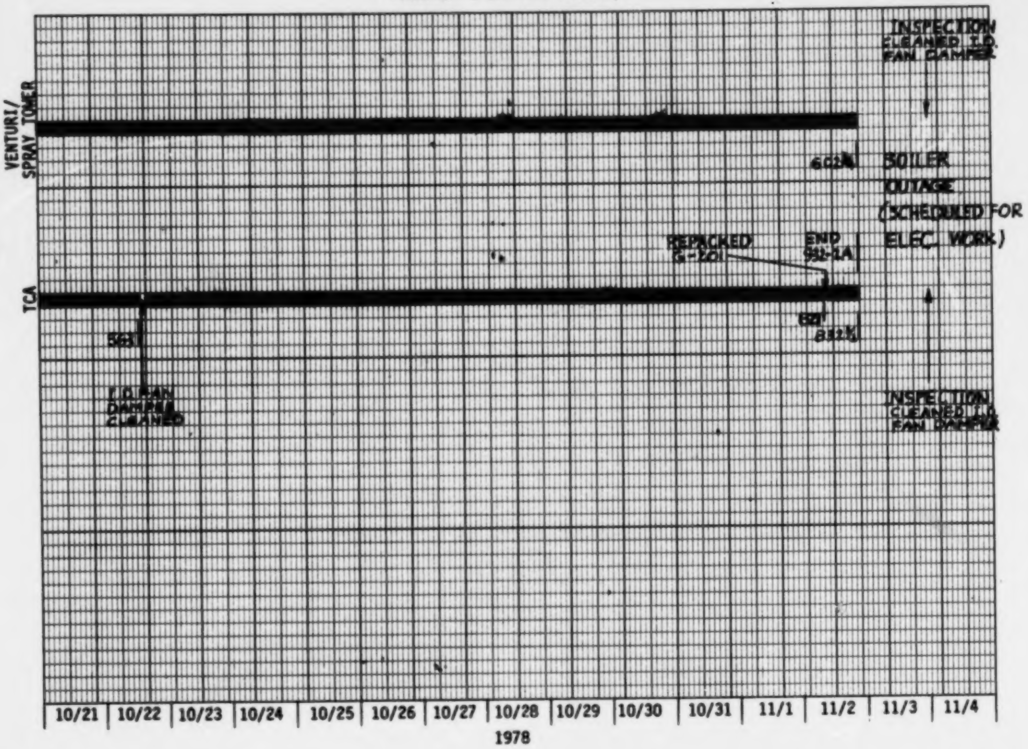

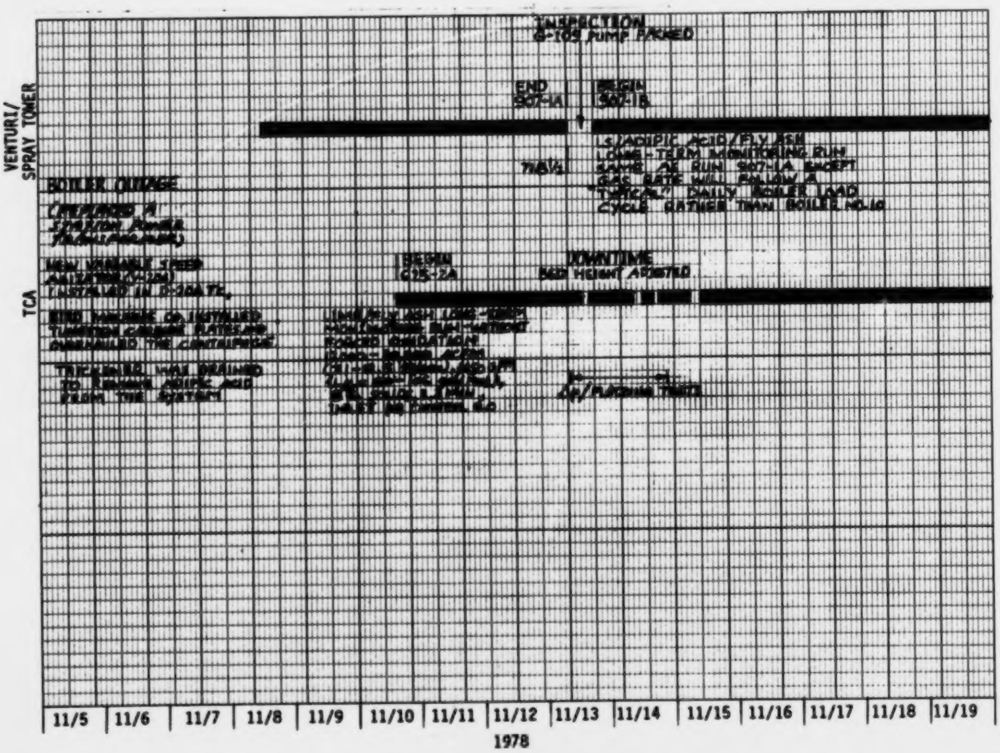

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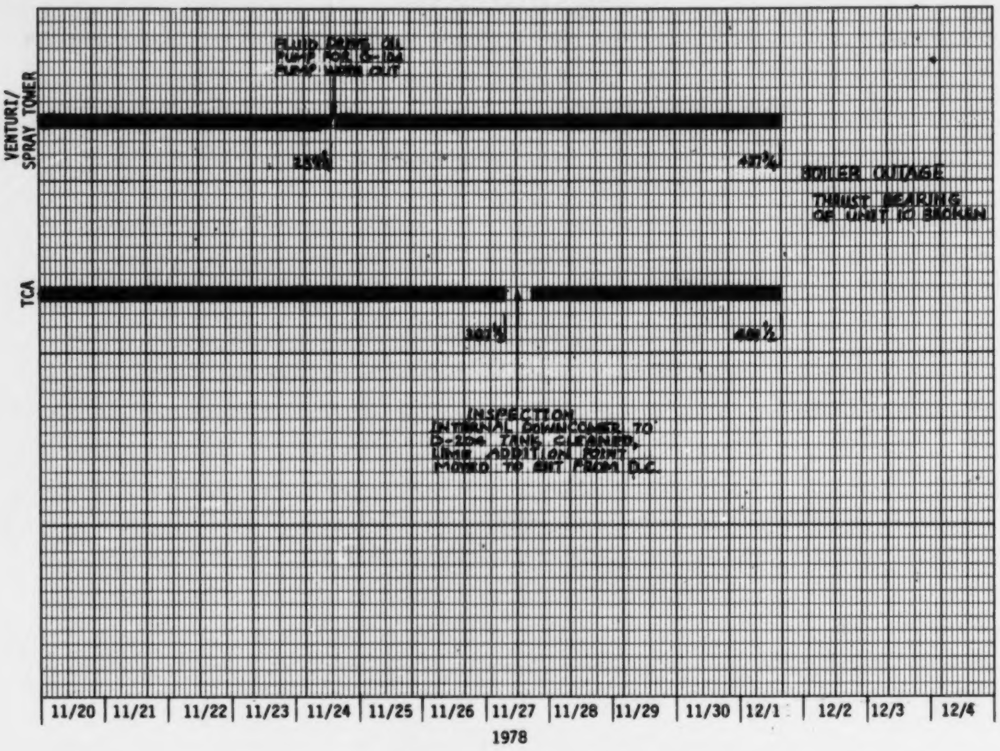

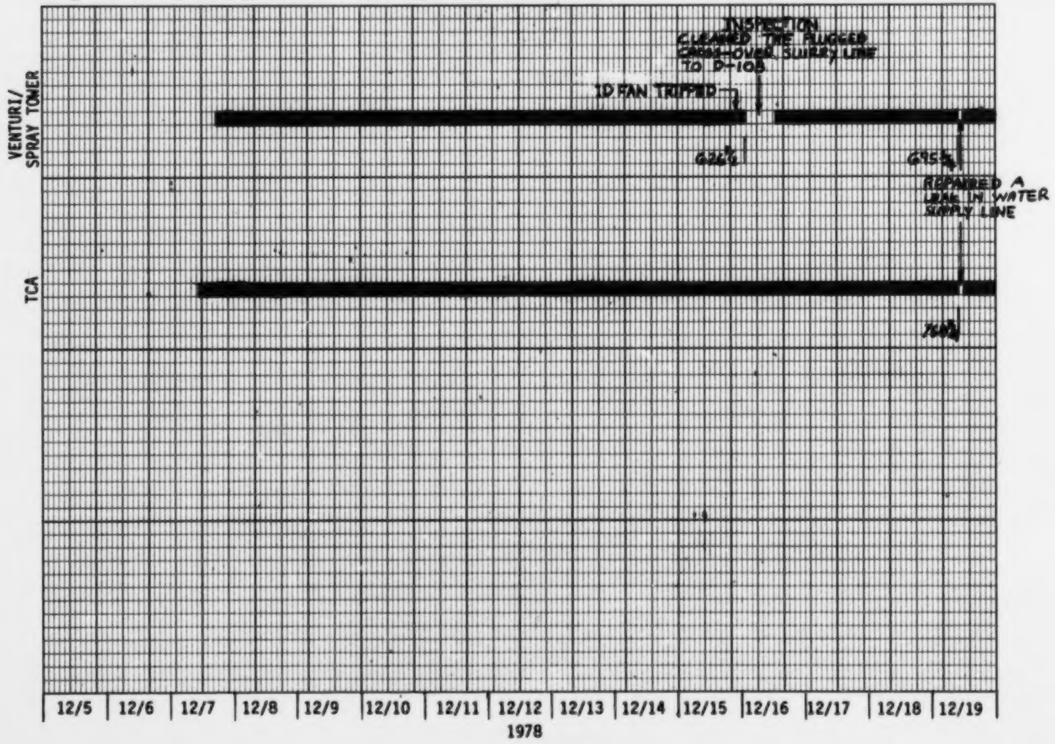

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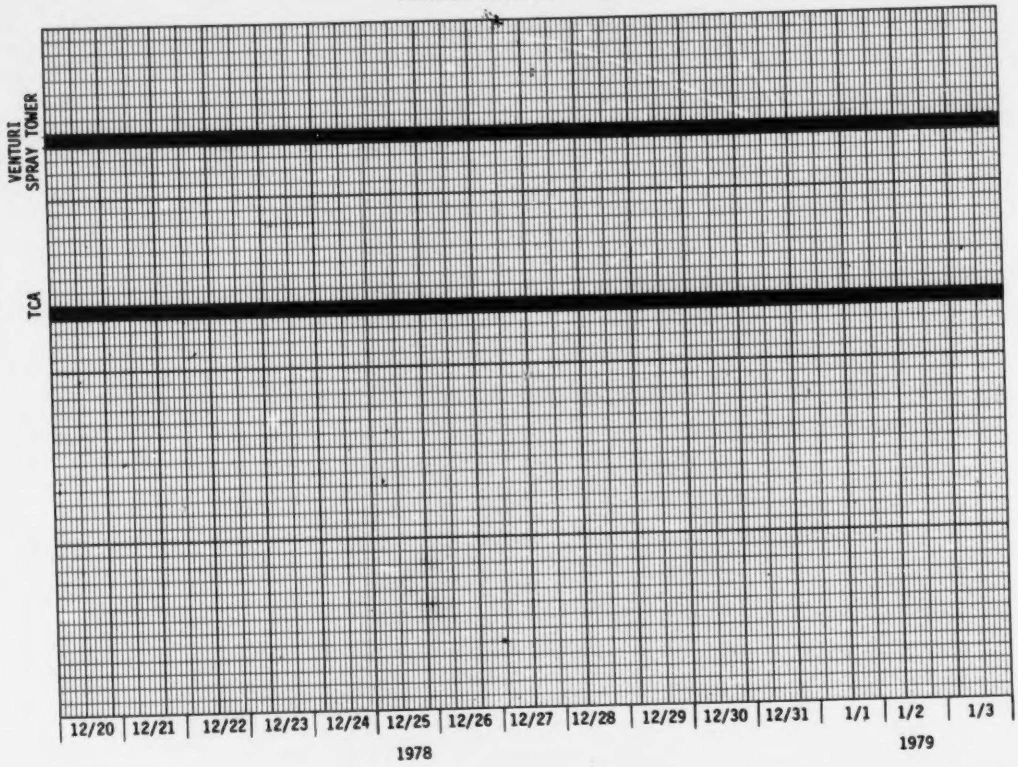
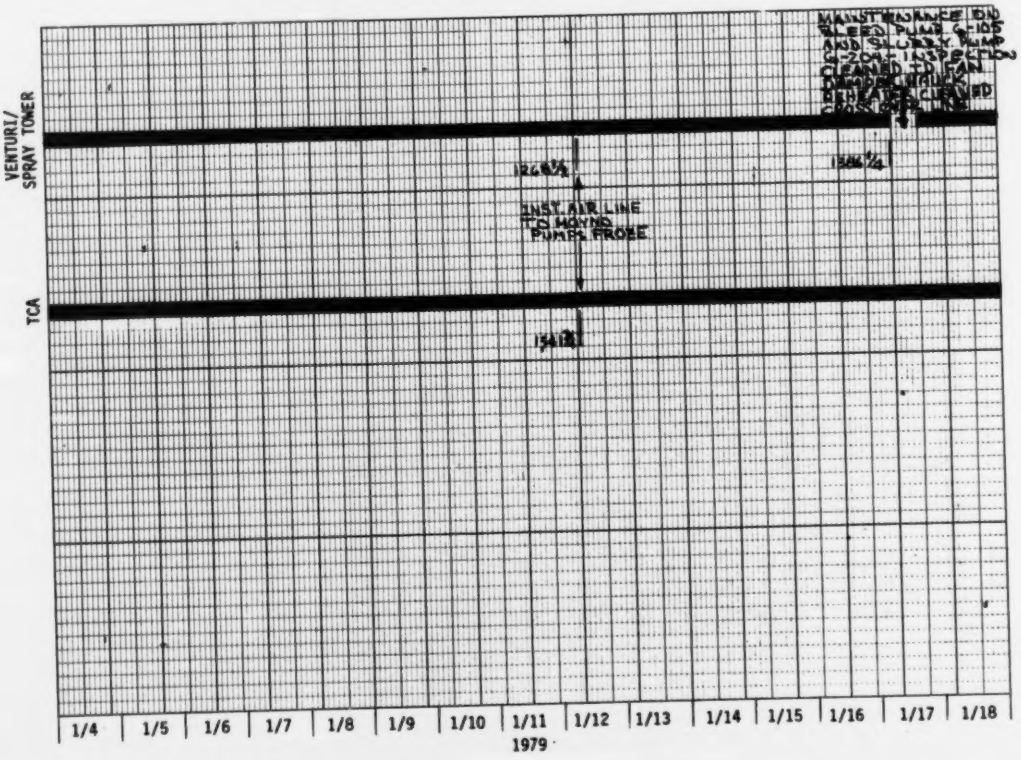




MAINTENANCE ON
BLEED PUMP G-105
AND SLURRY PUMP
G-204 - INSPECTION
CLEANED ID FAN
DAMPER [illegible]
REHEATER, CLEANED
CROSS [illegible] LINE

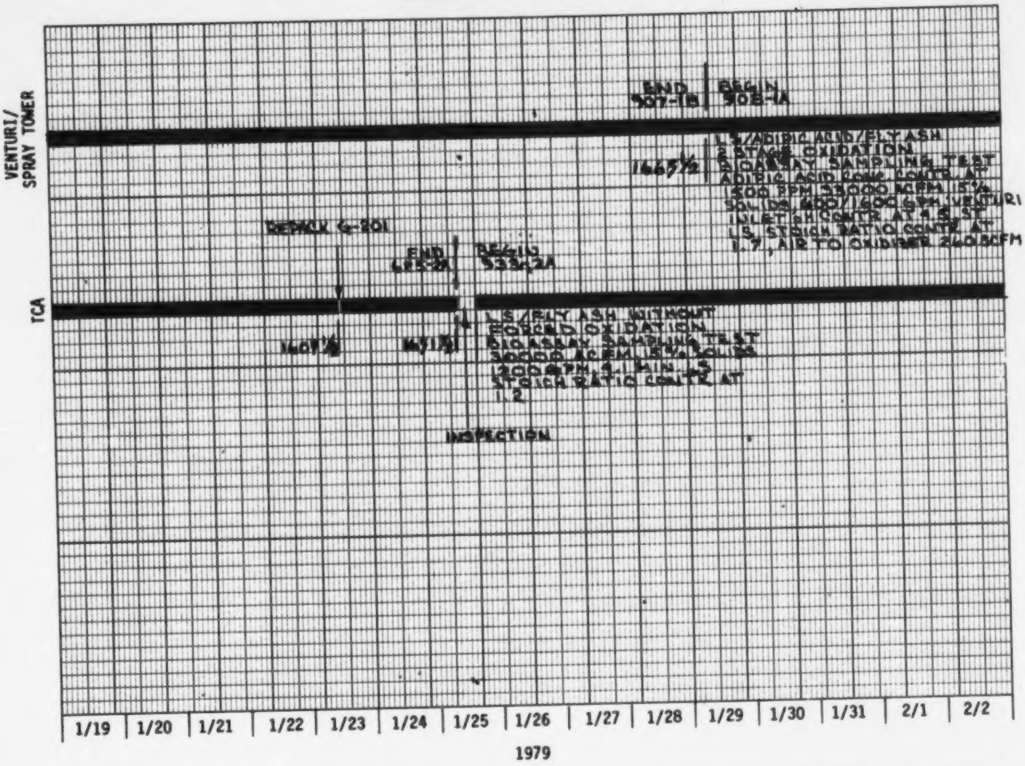
1586¼

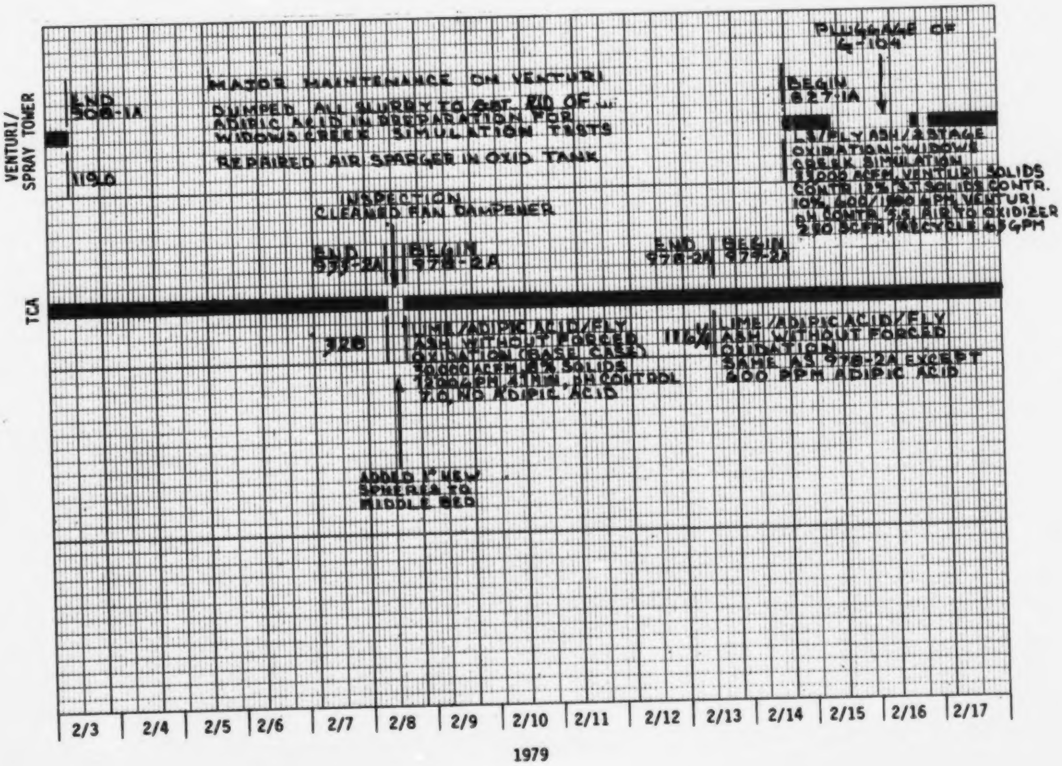
1266½

INST. AIR LINE
TO HOYND
PUMPS FROZE

1541½

SCRUBBER OPERATING PERIODS





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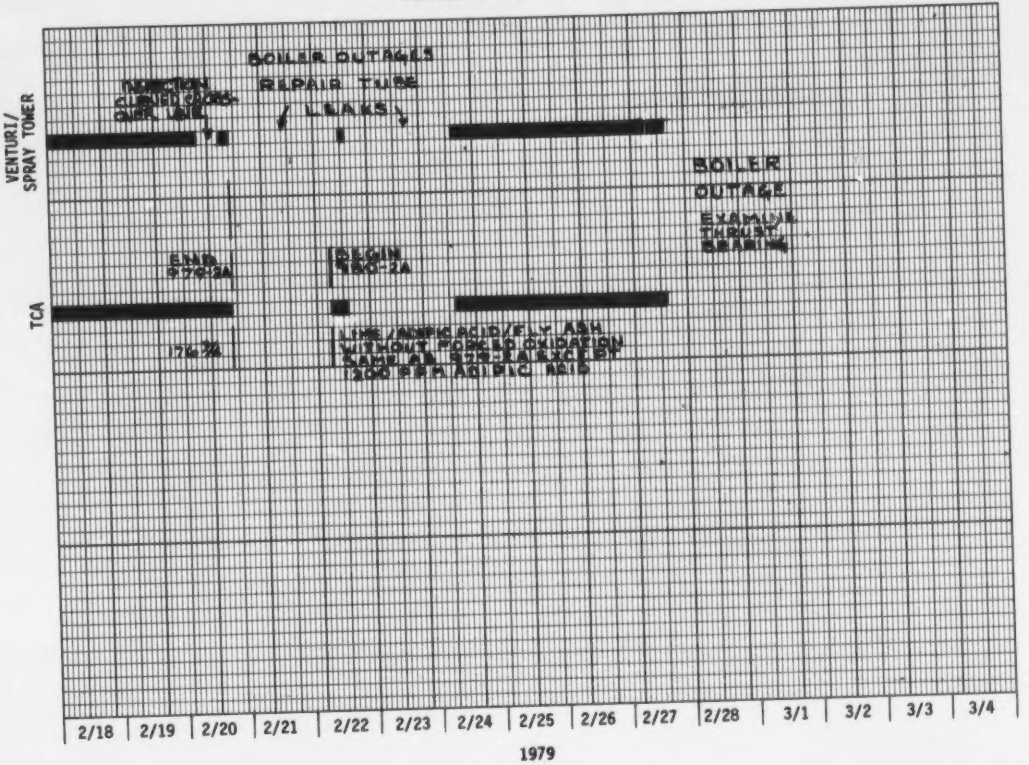

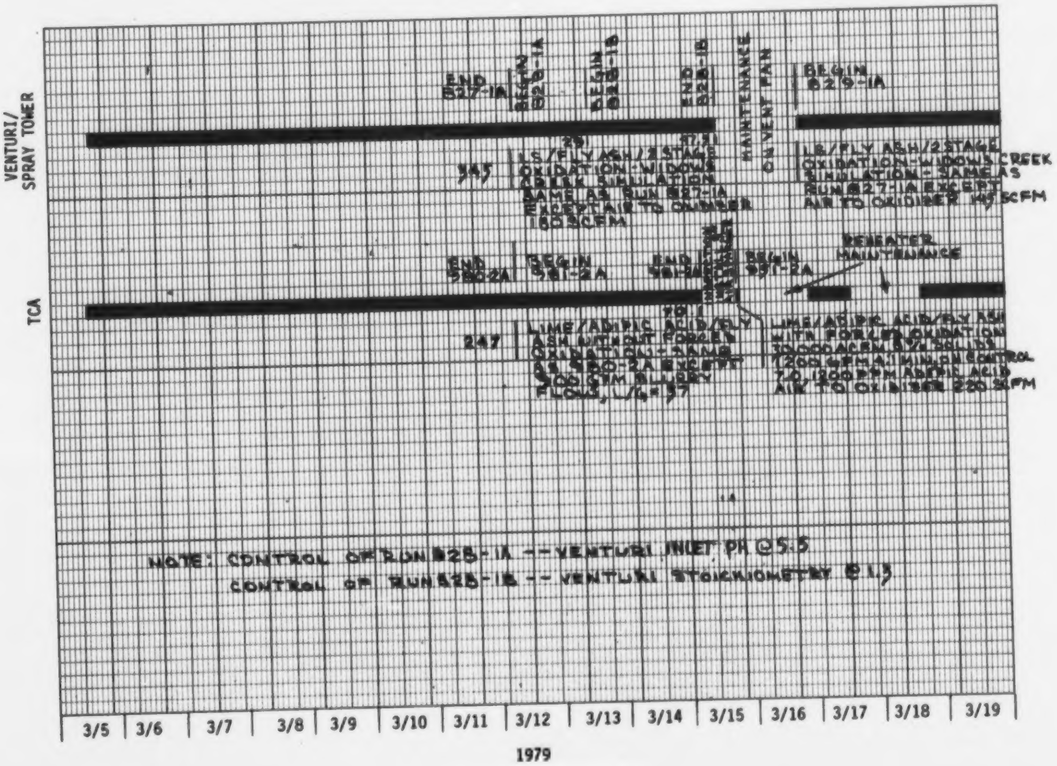

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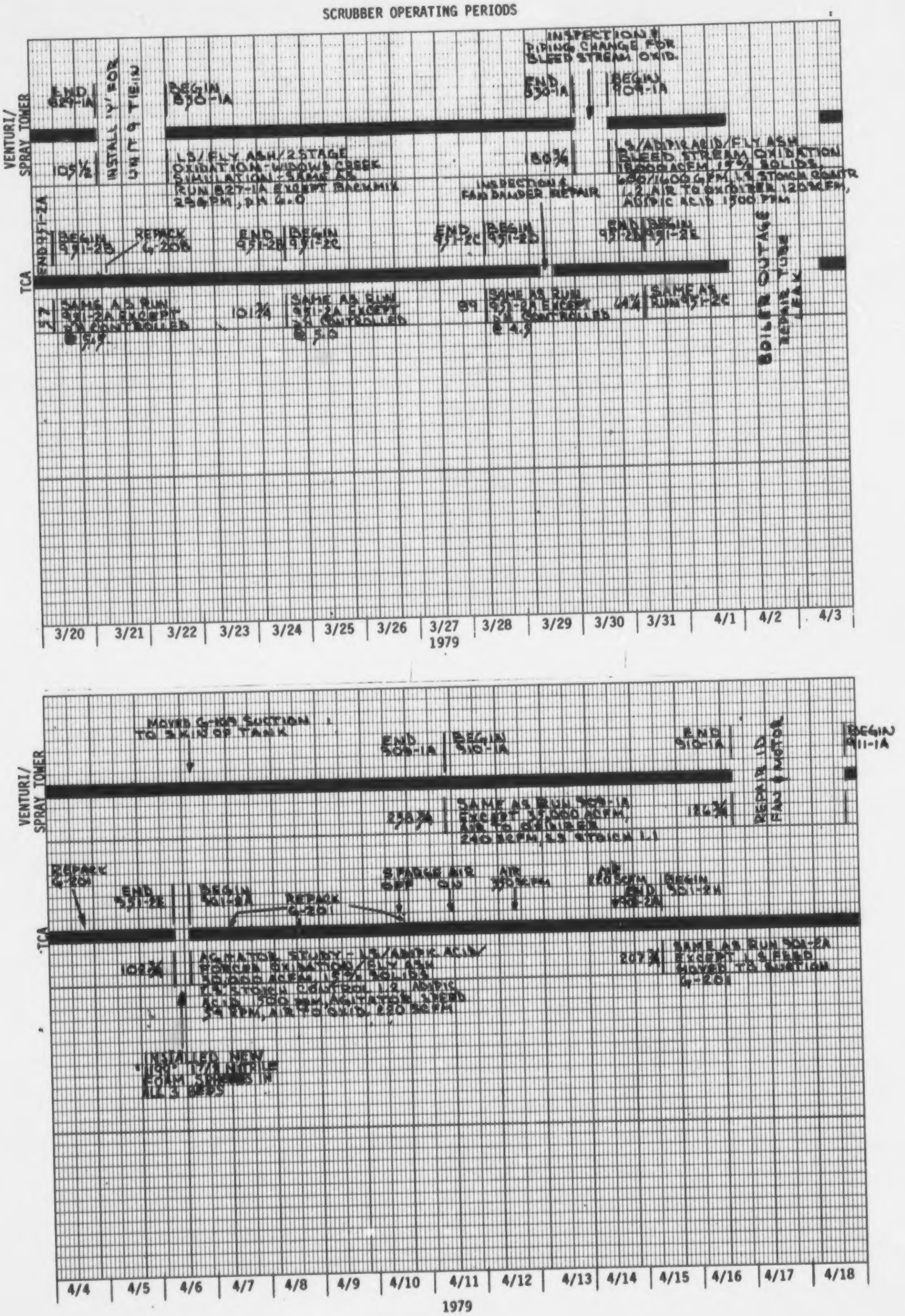

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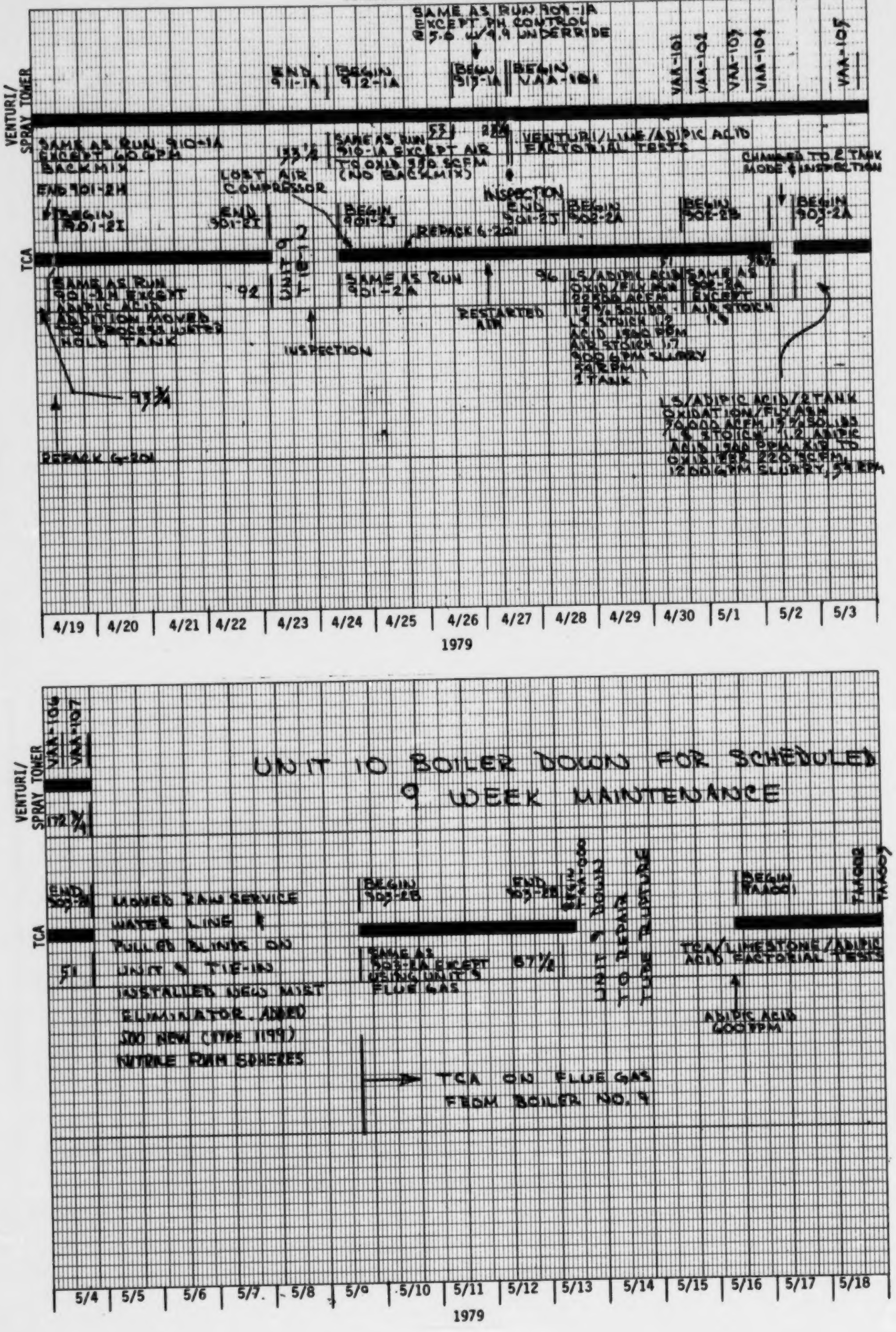

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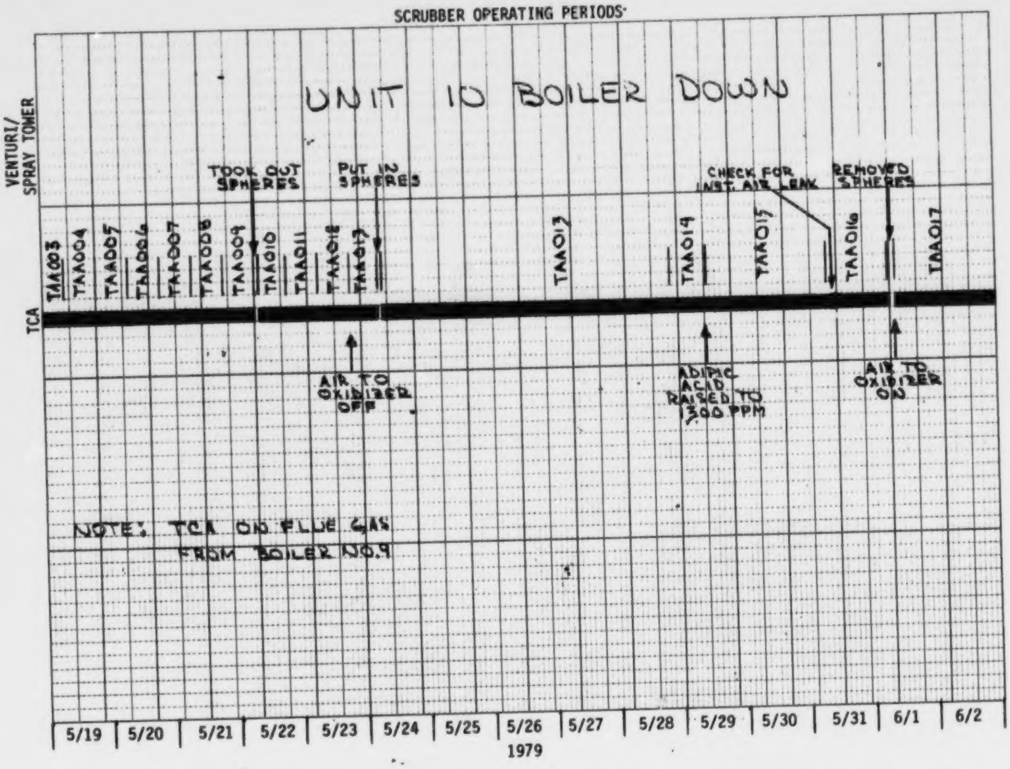

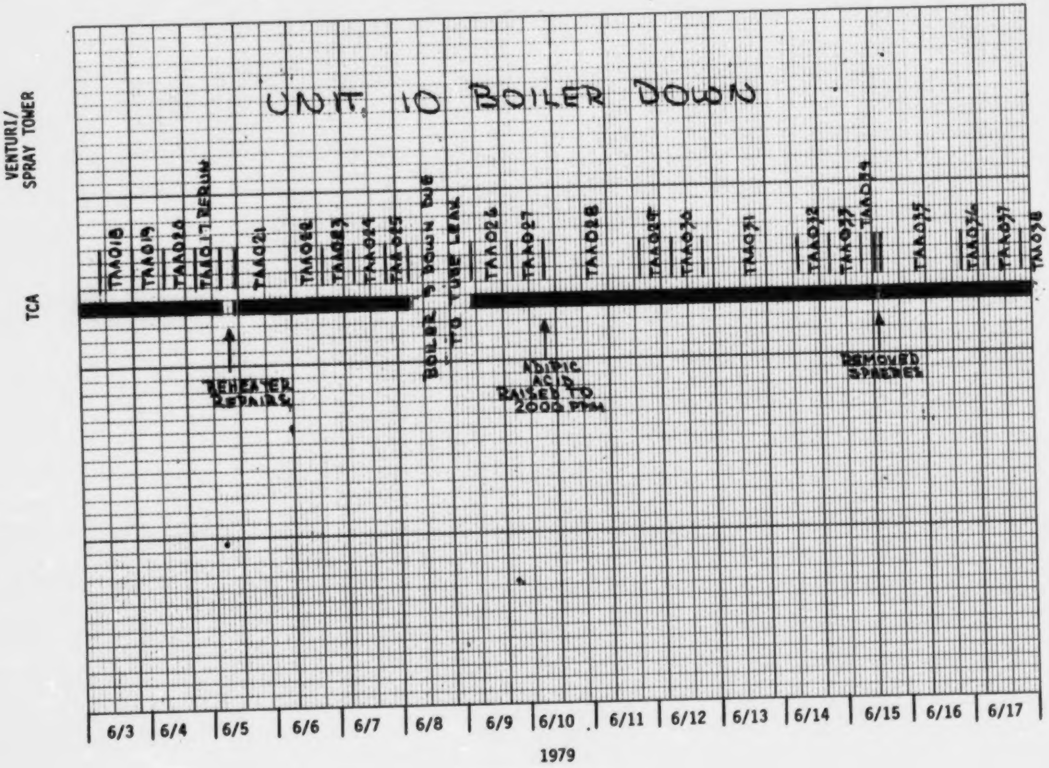

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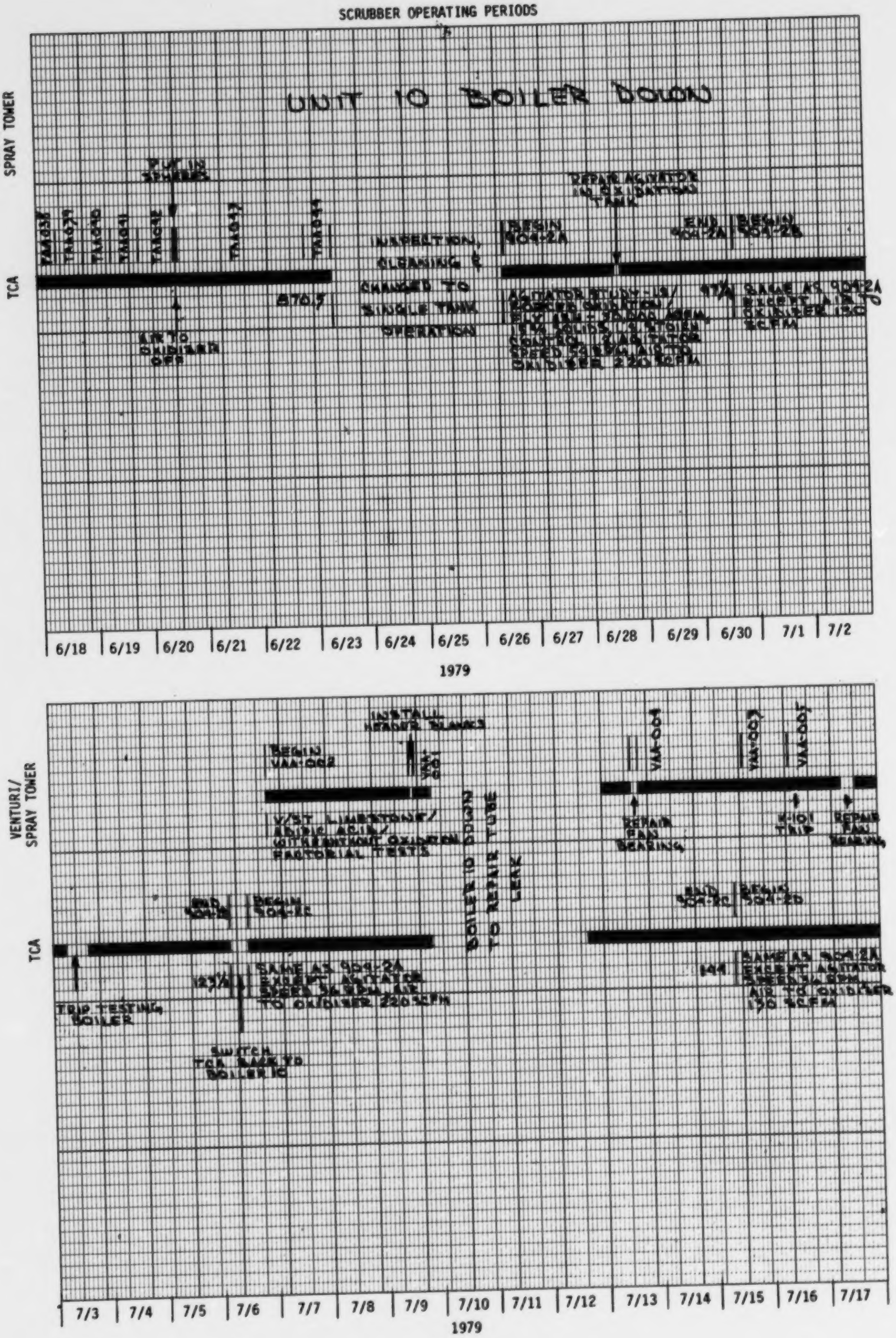

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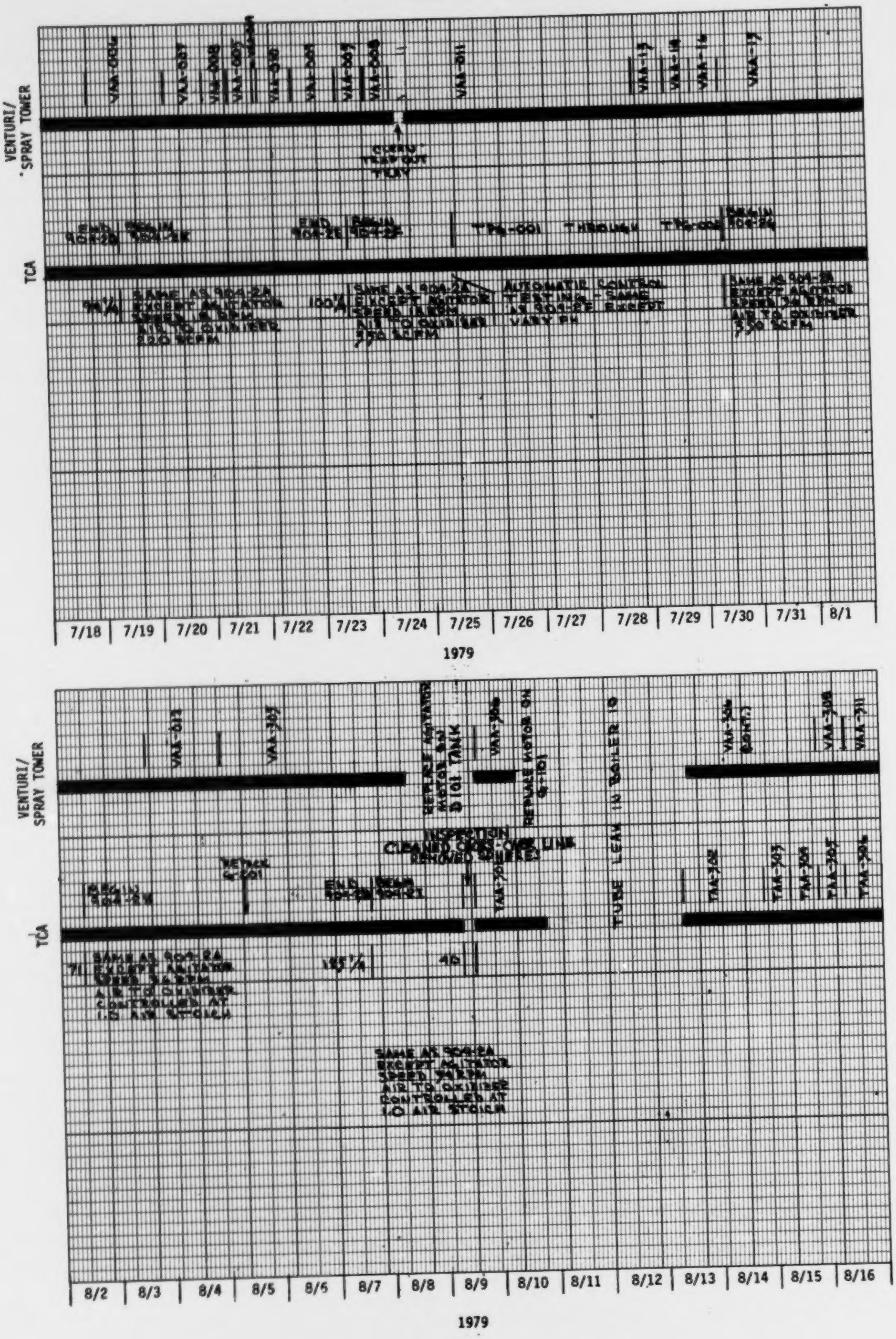

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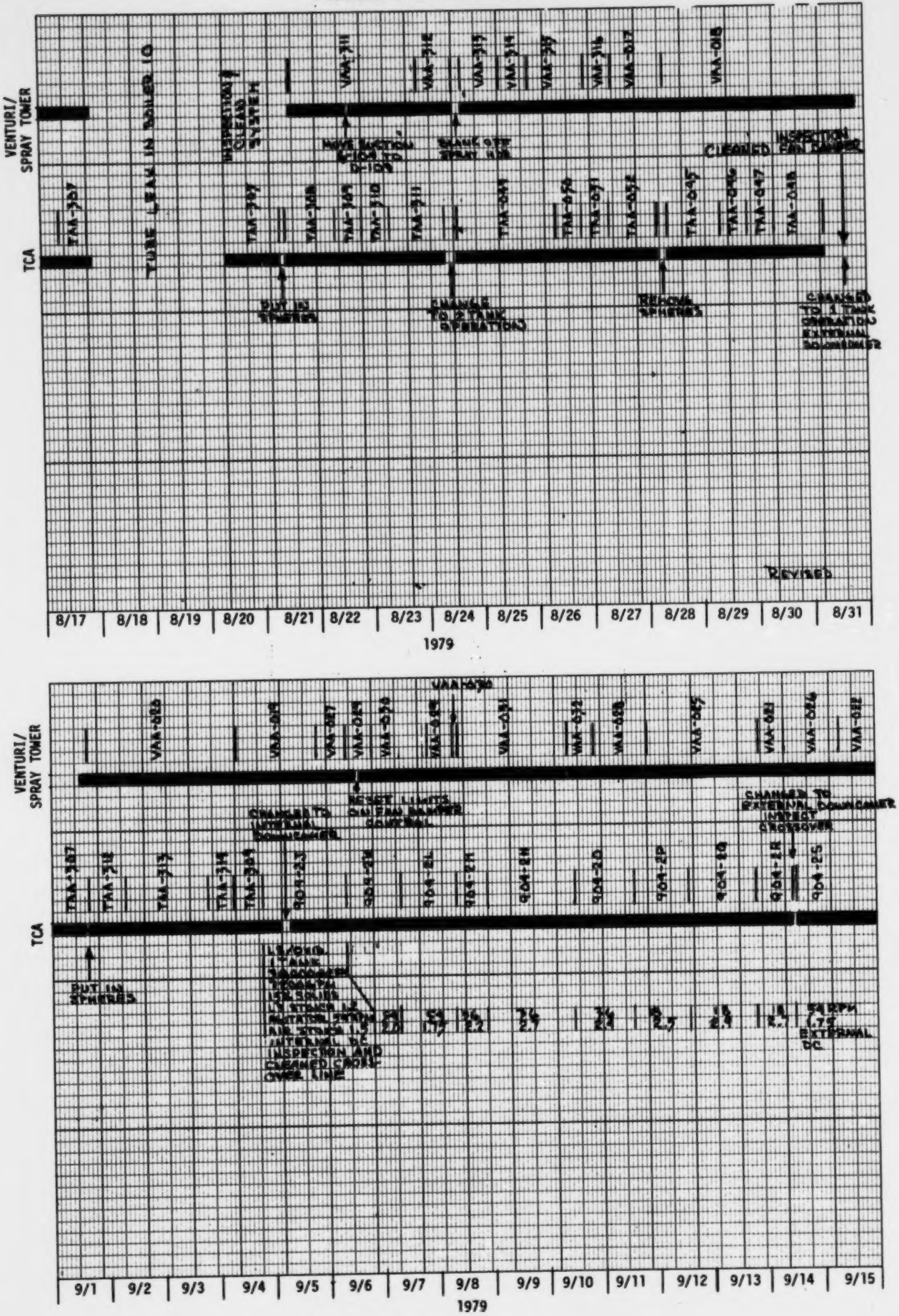

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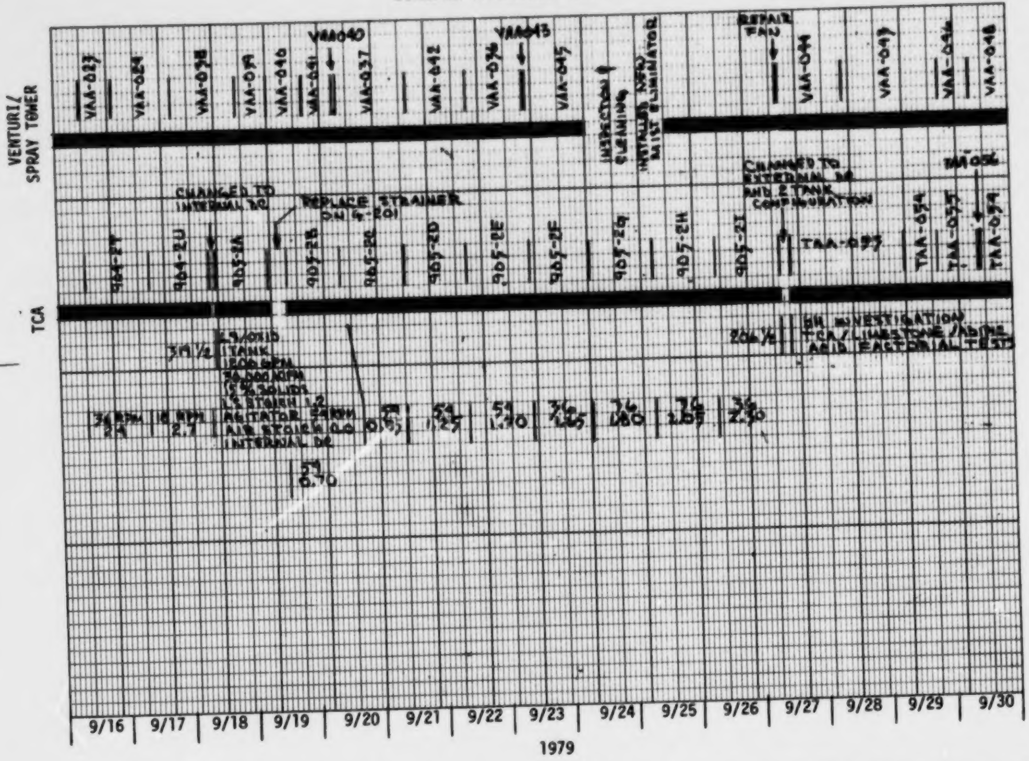

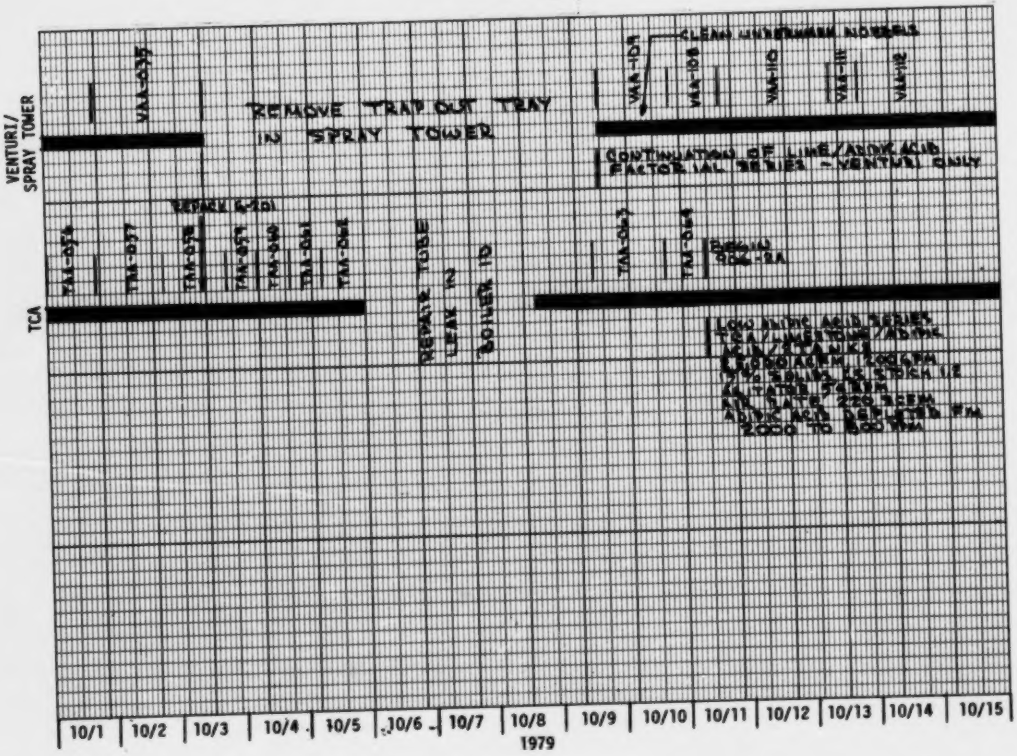

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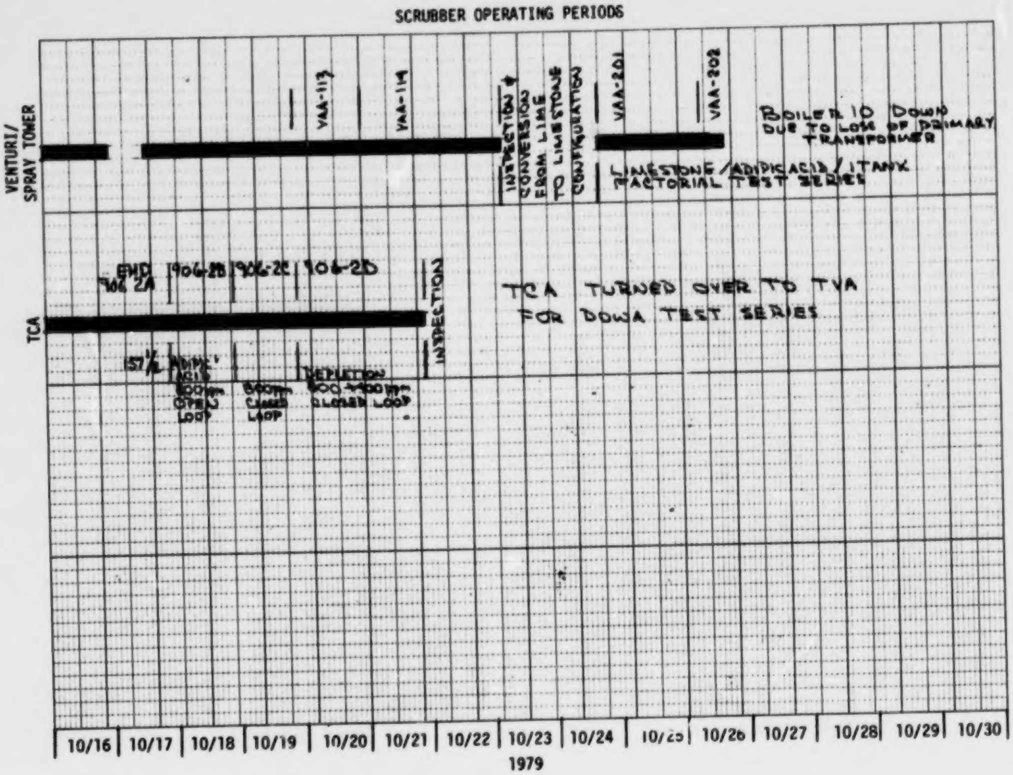

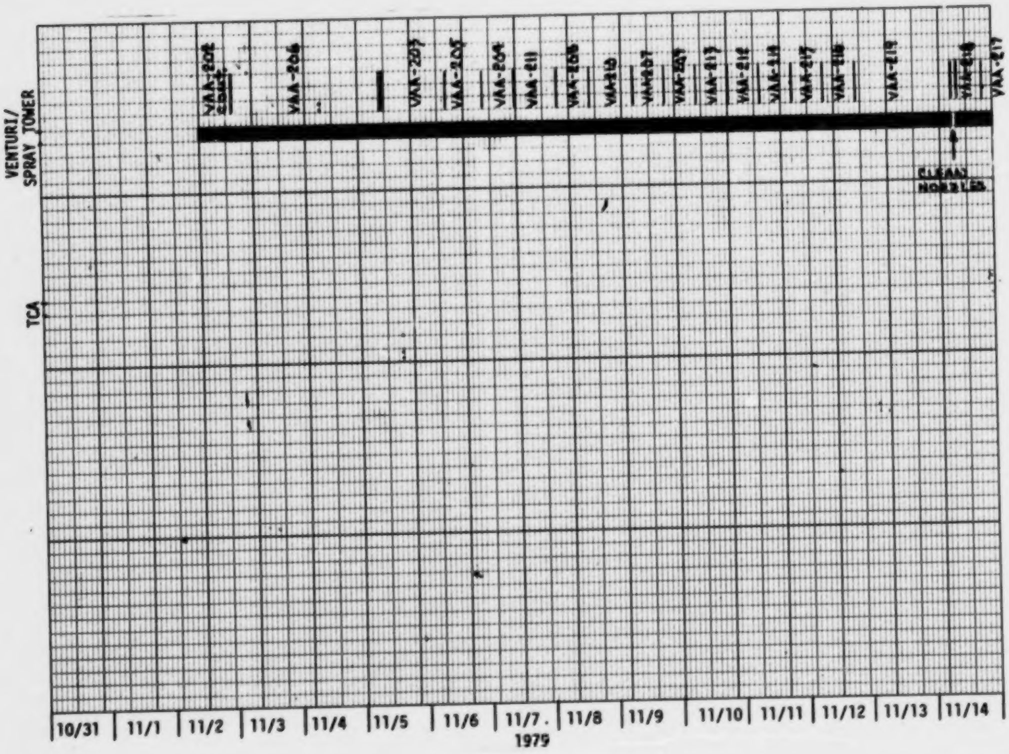

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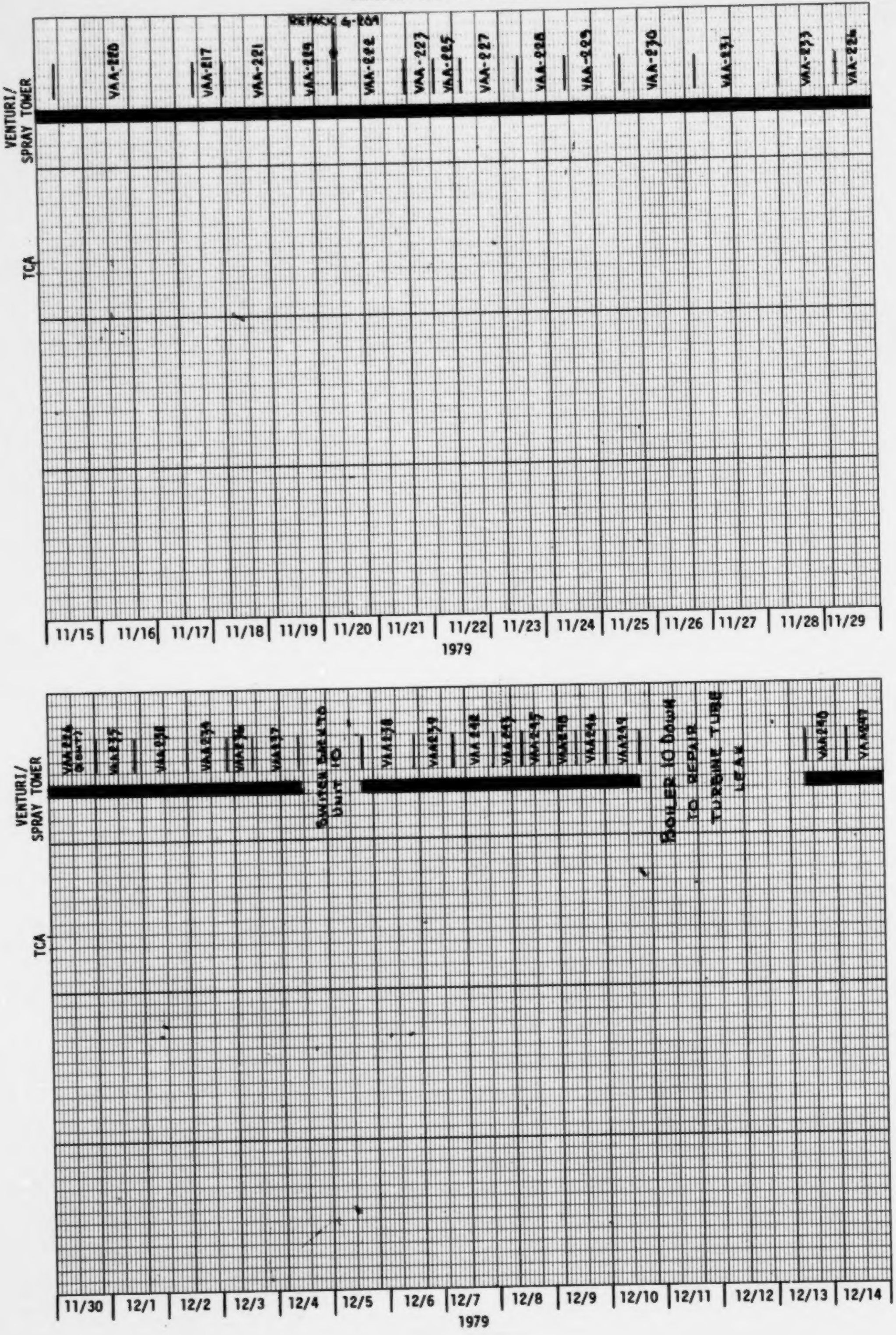

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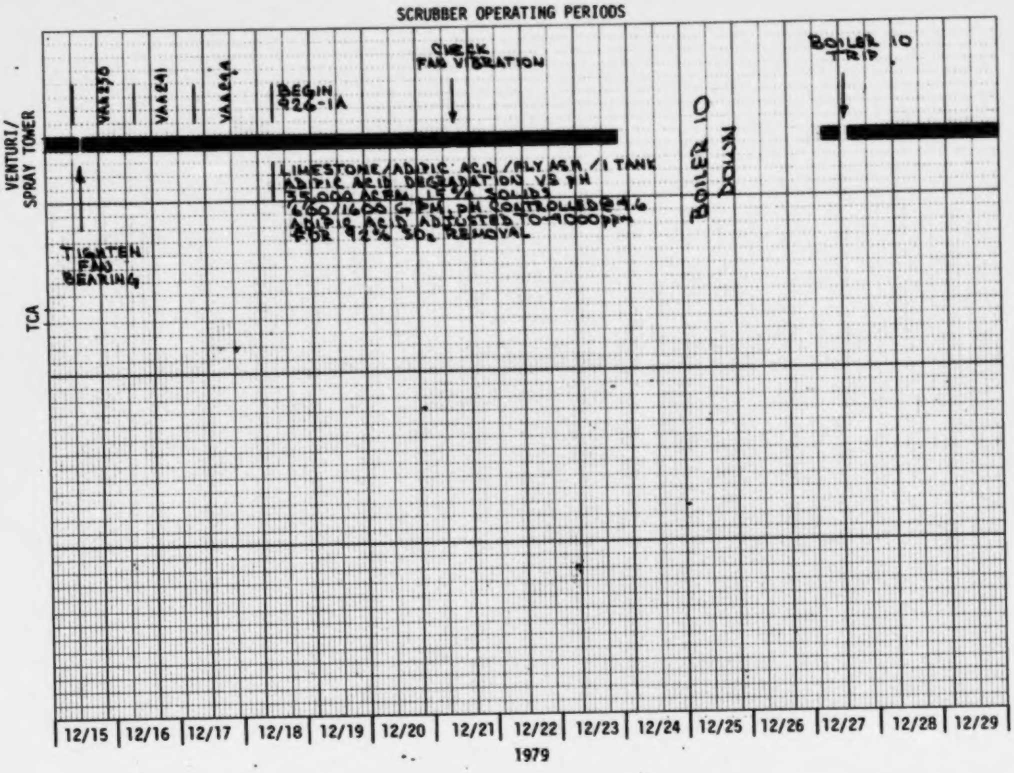

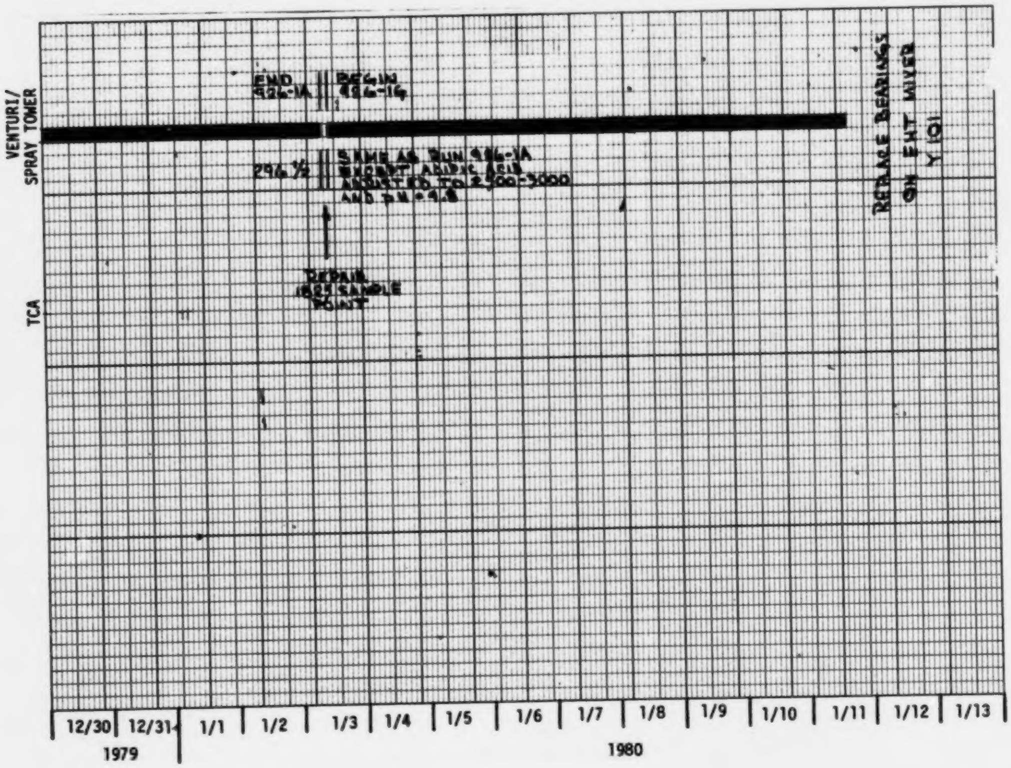

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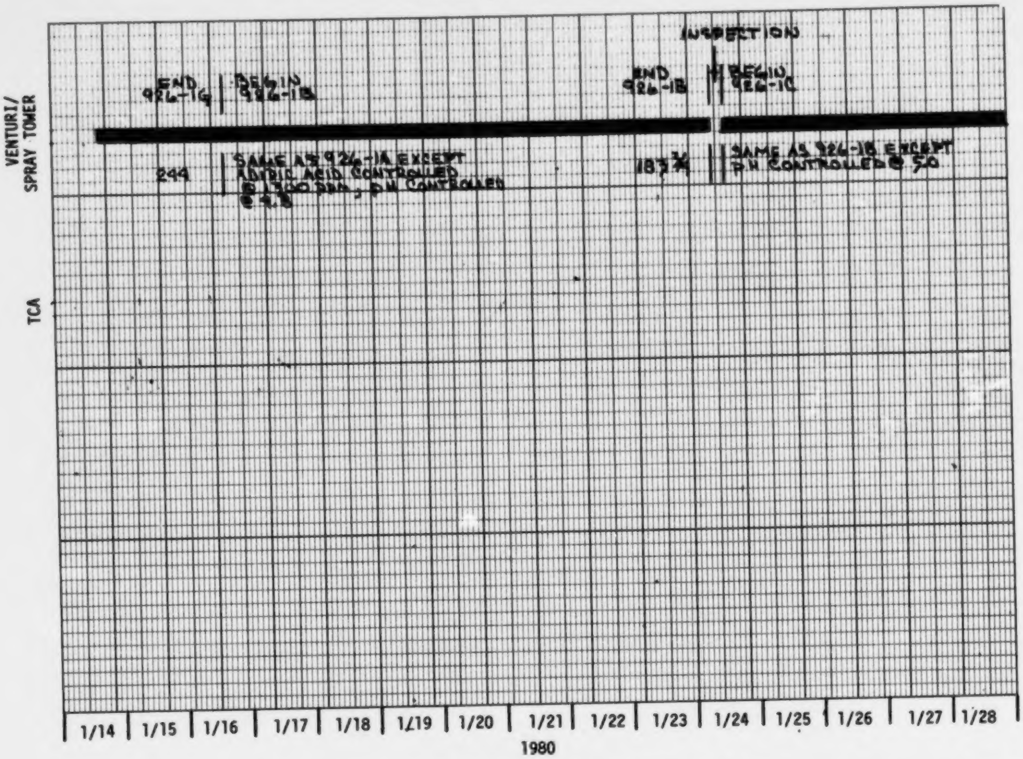

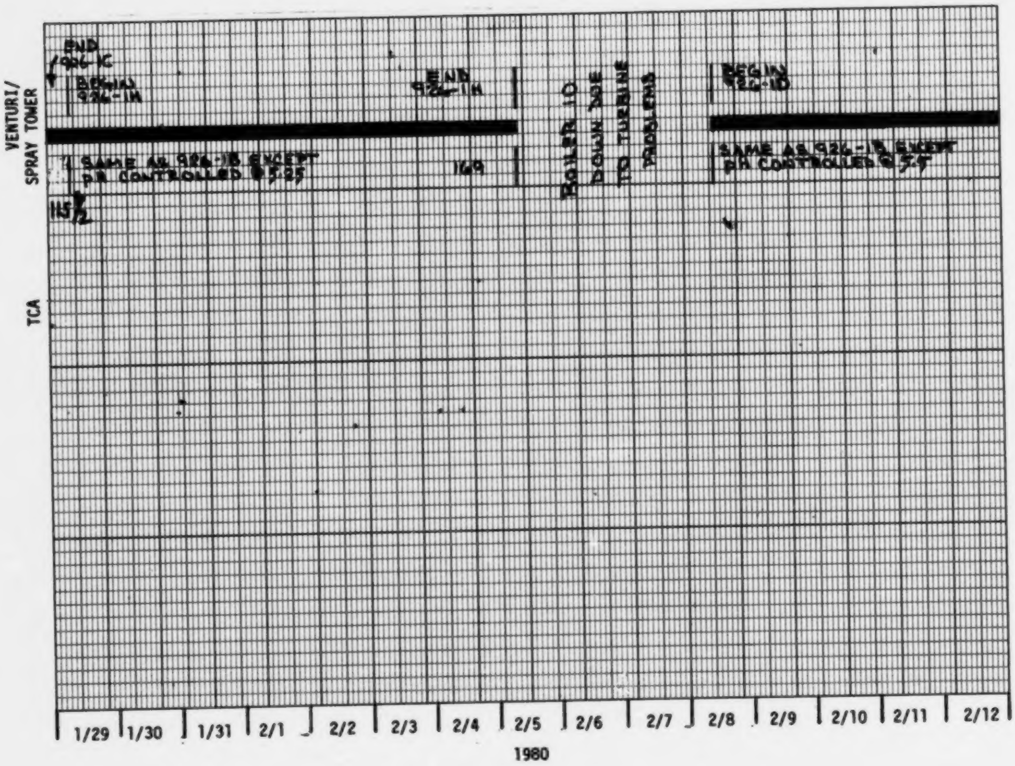

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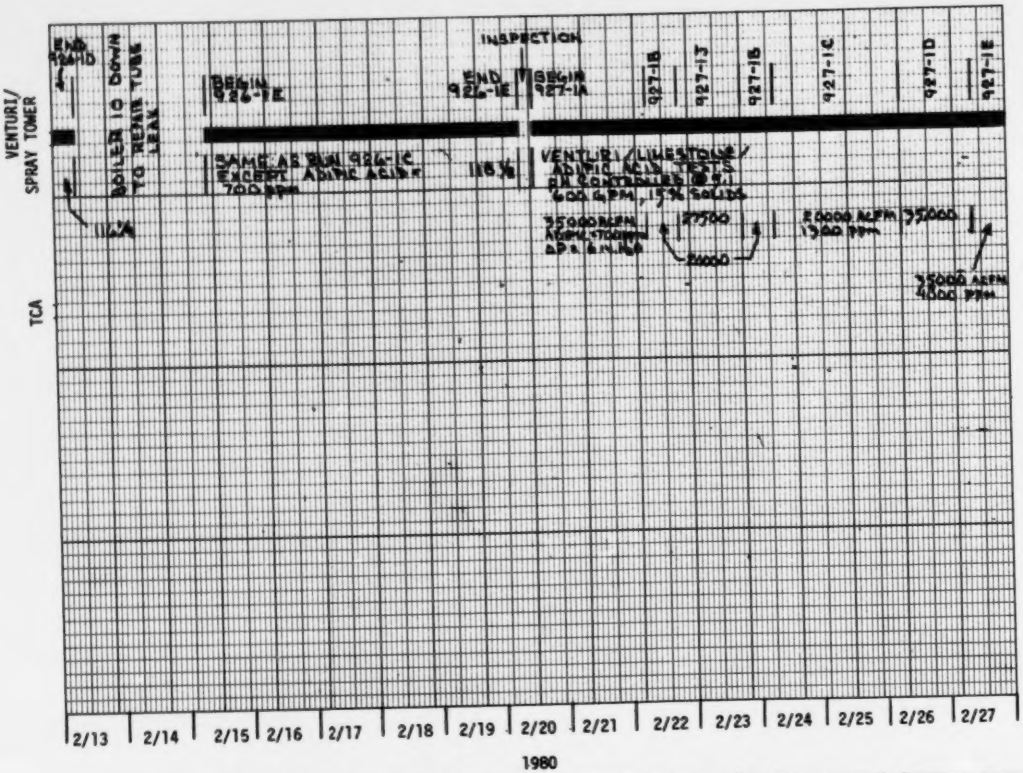

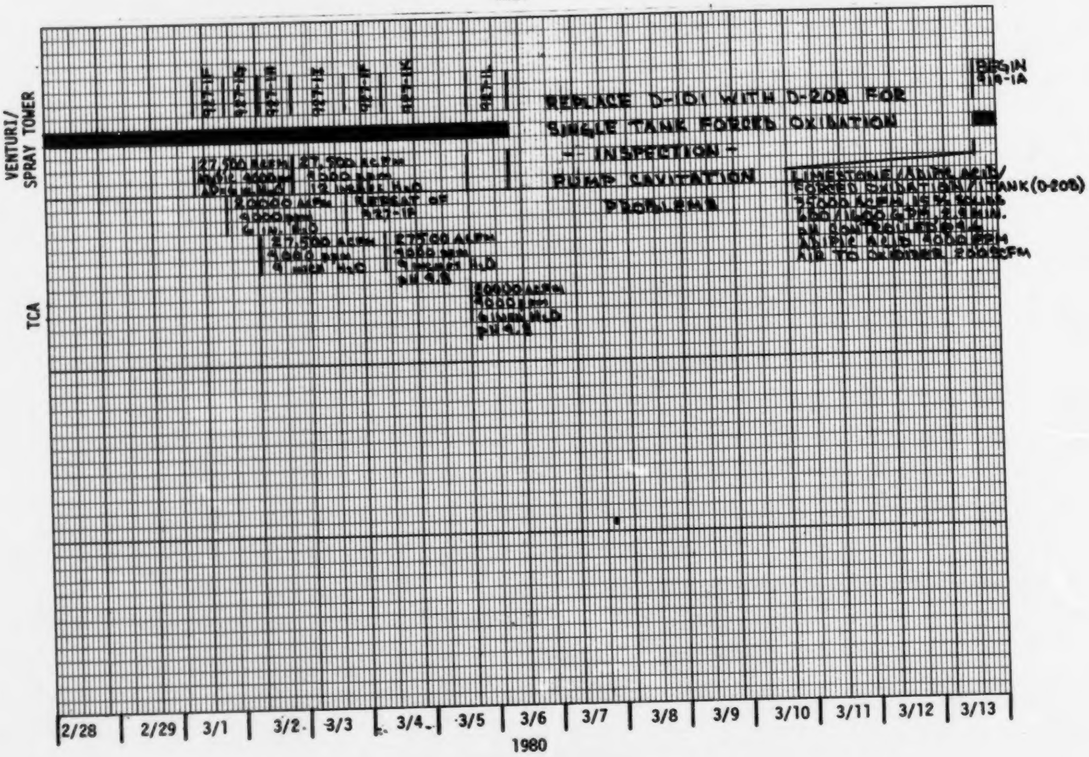

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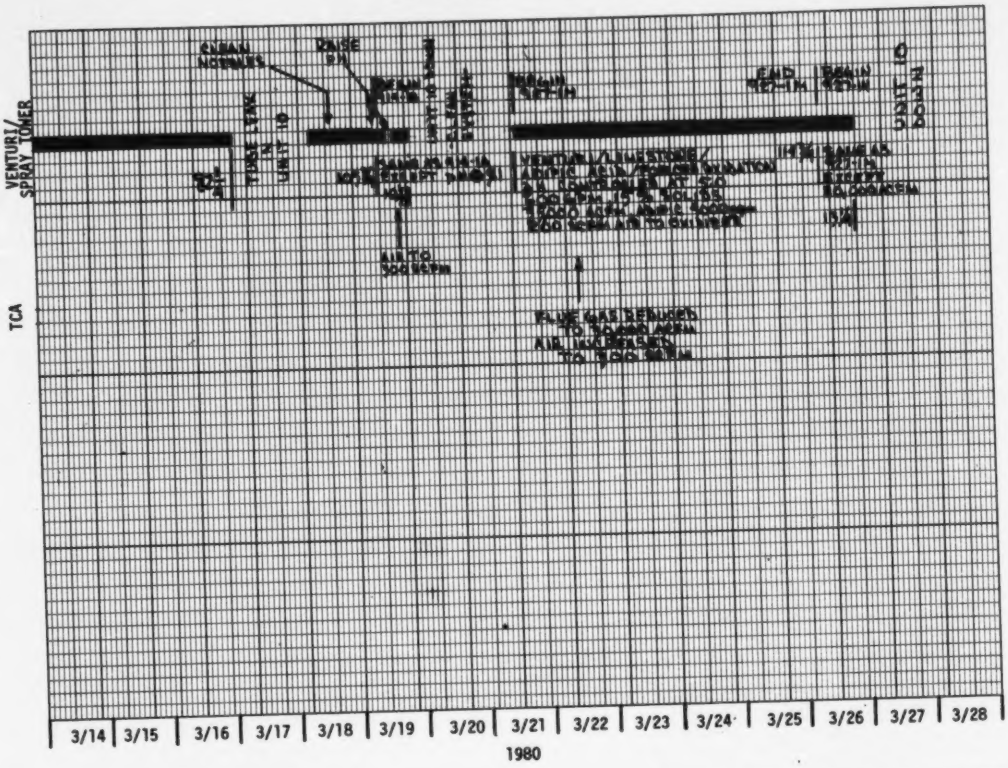

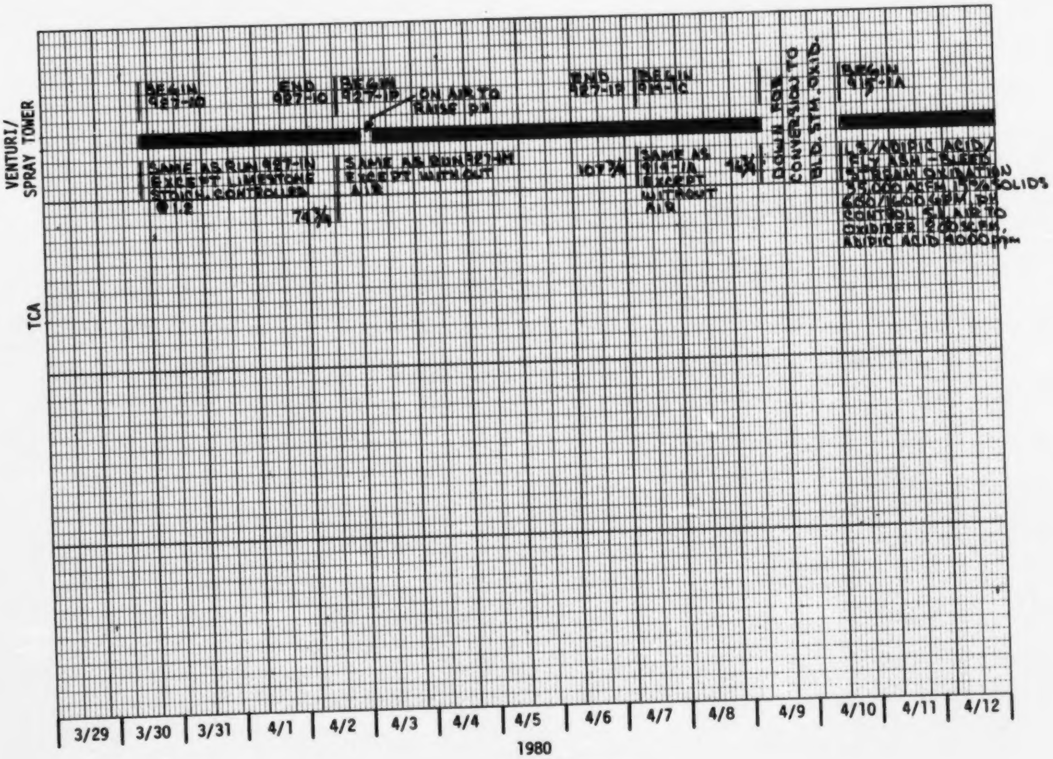

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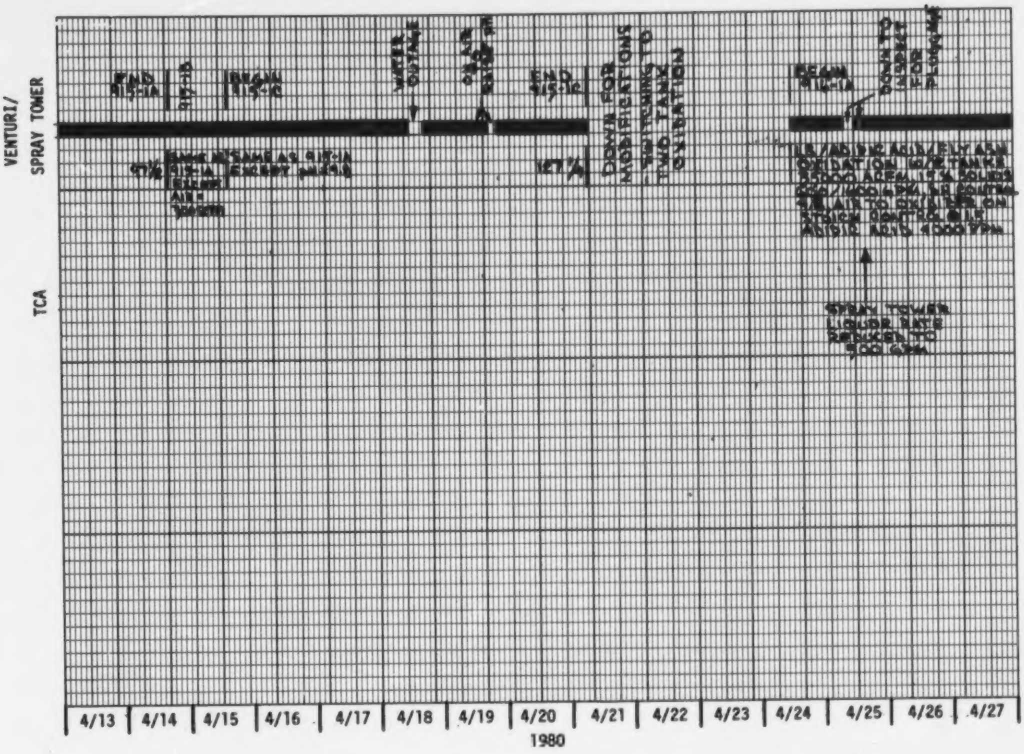

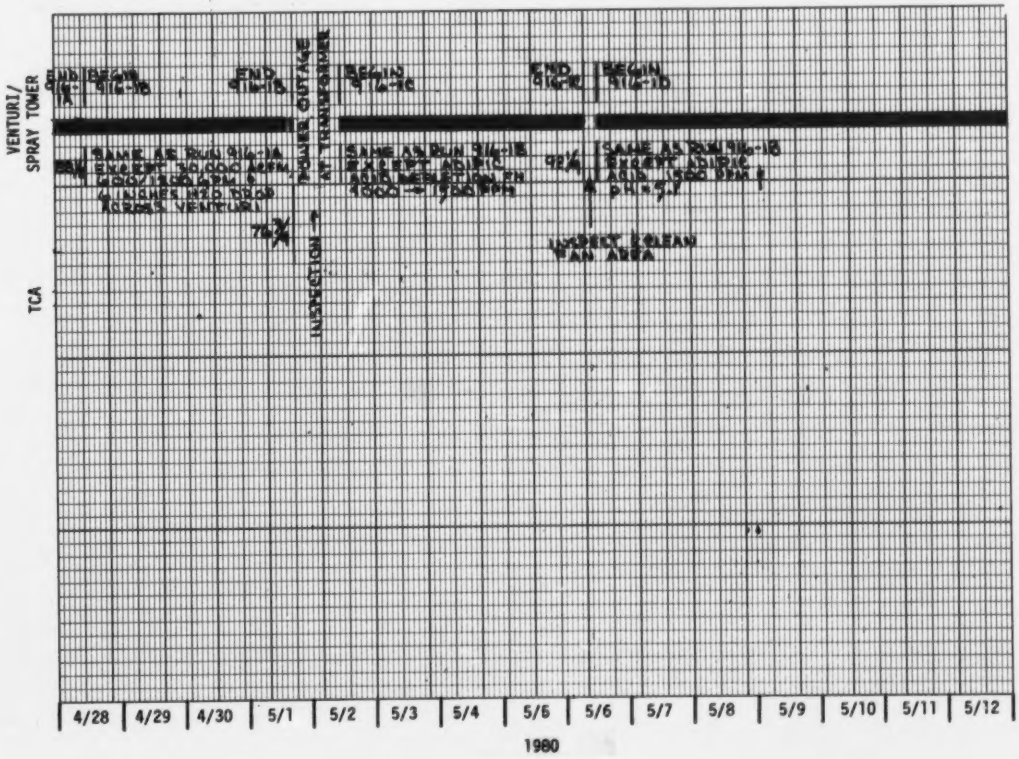

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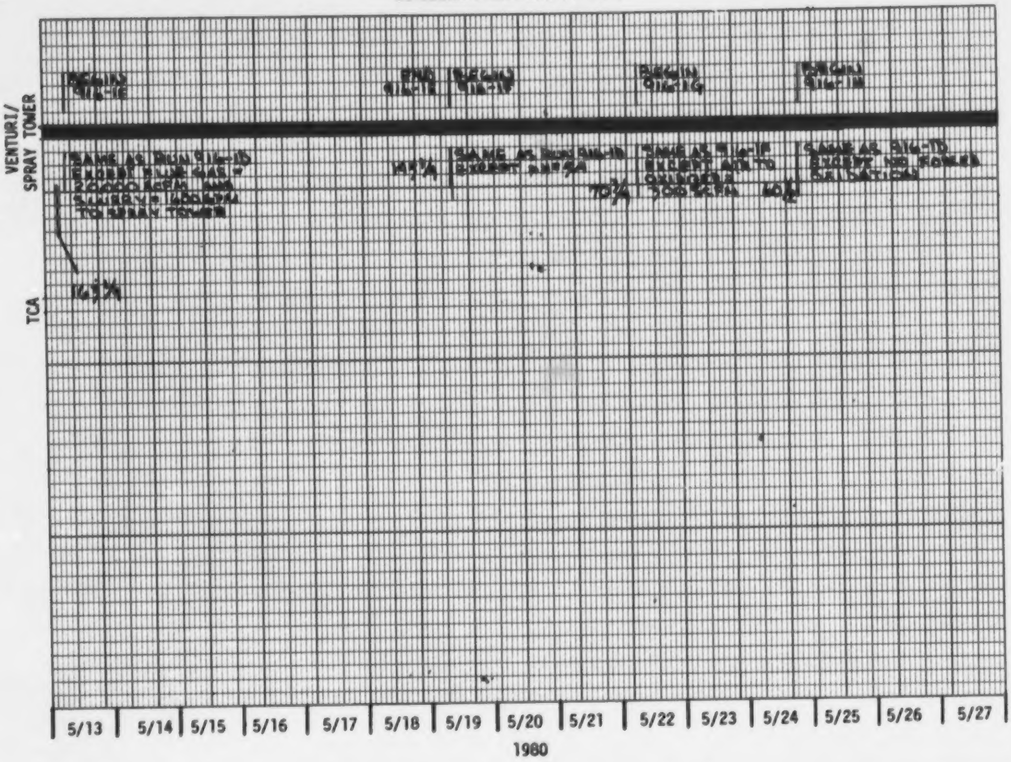

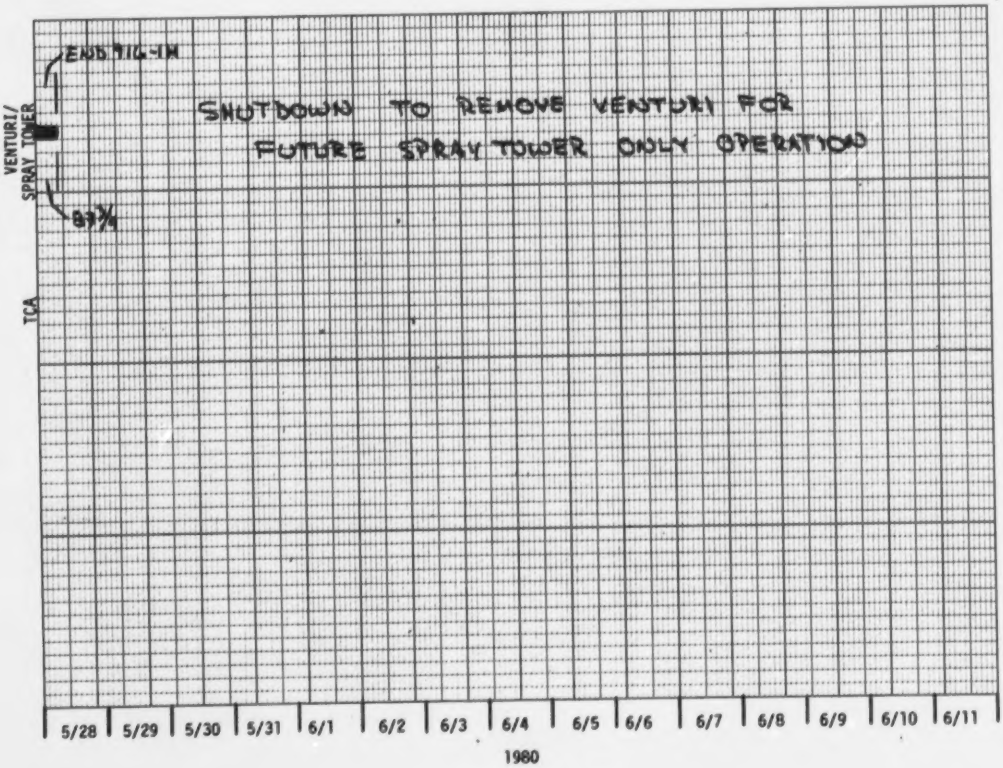

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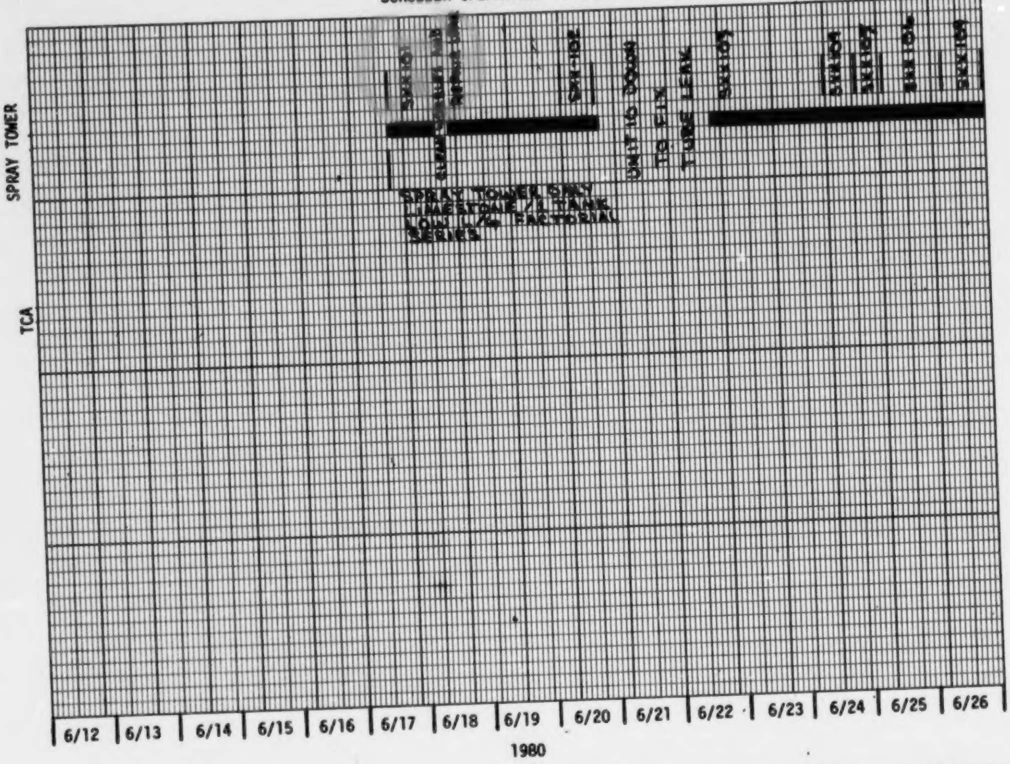

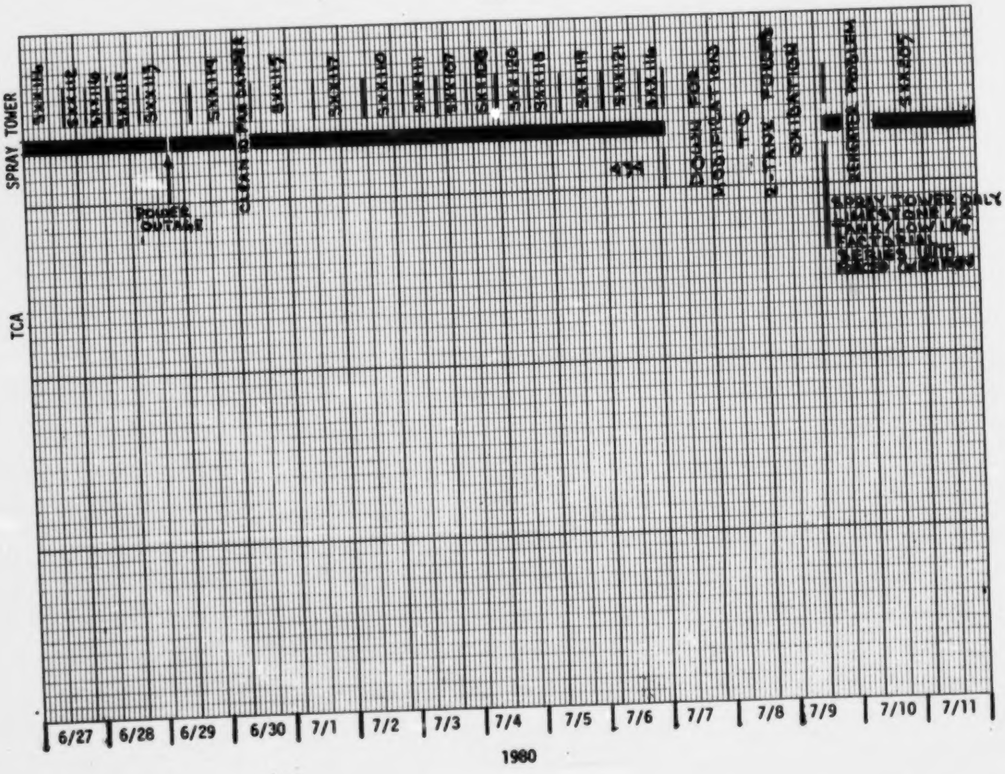

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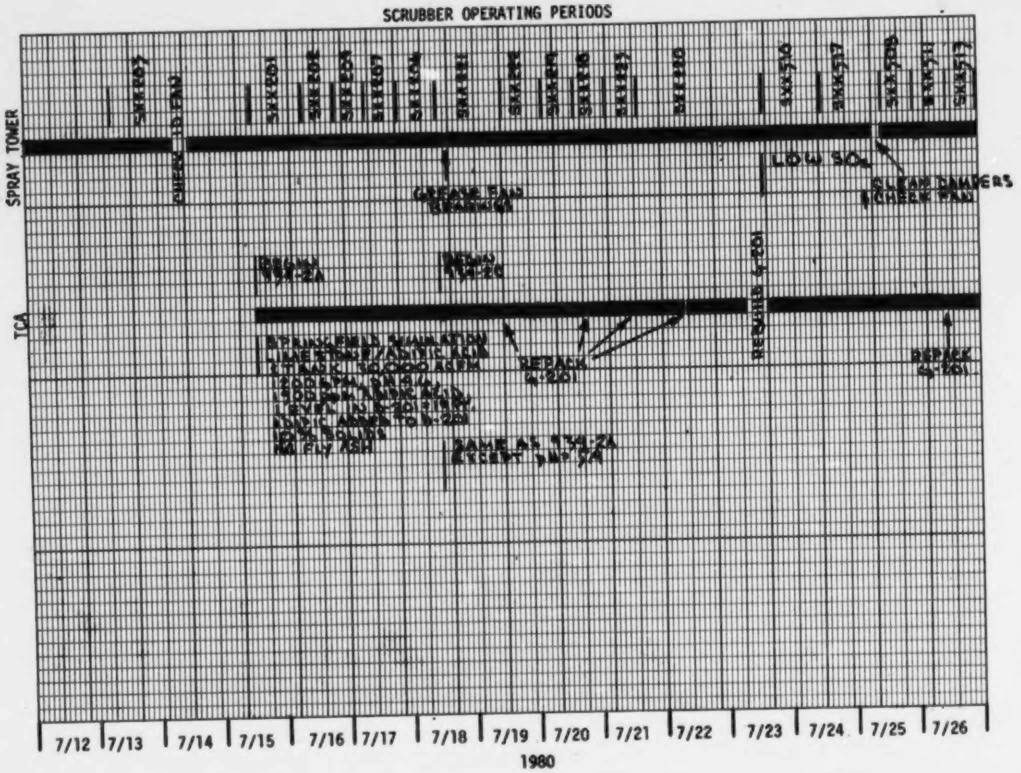

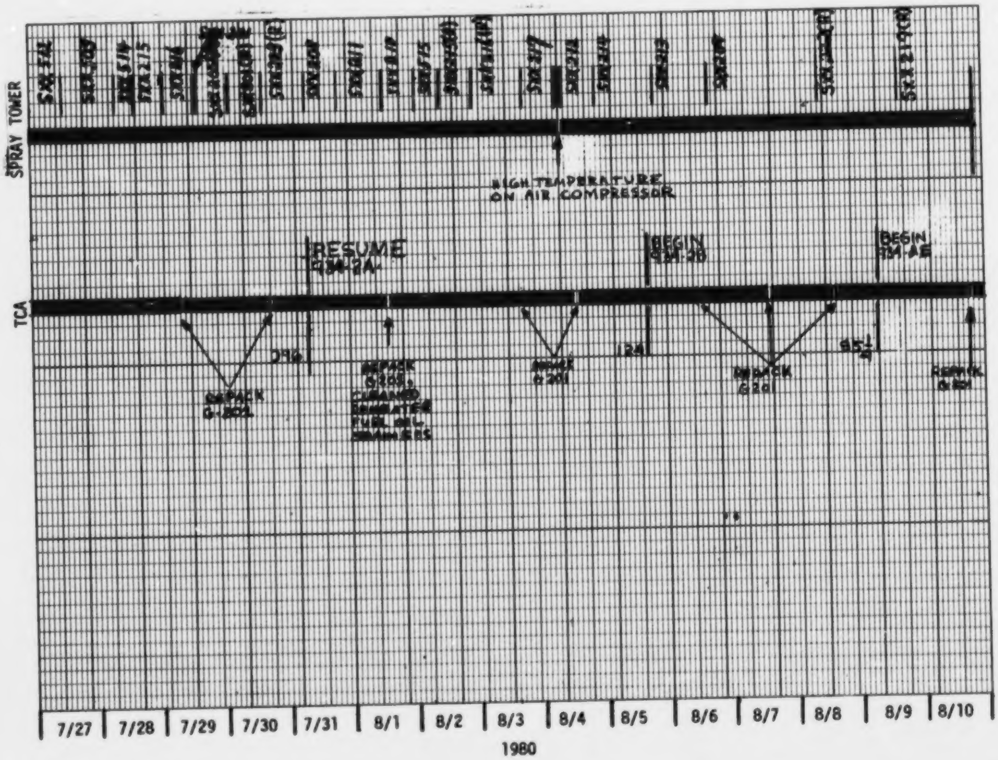

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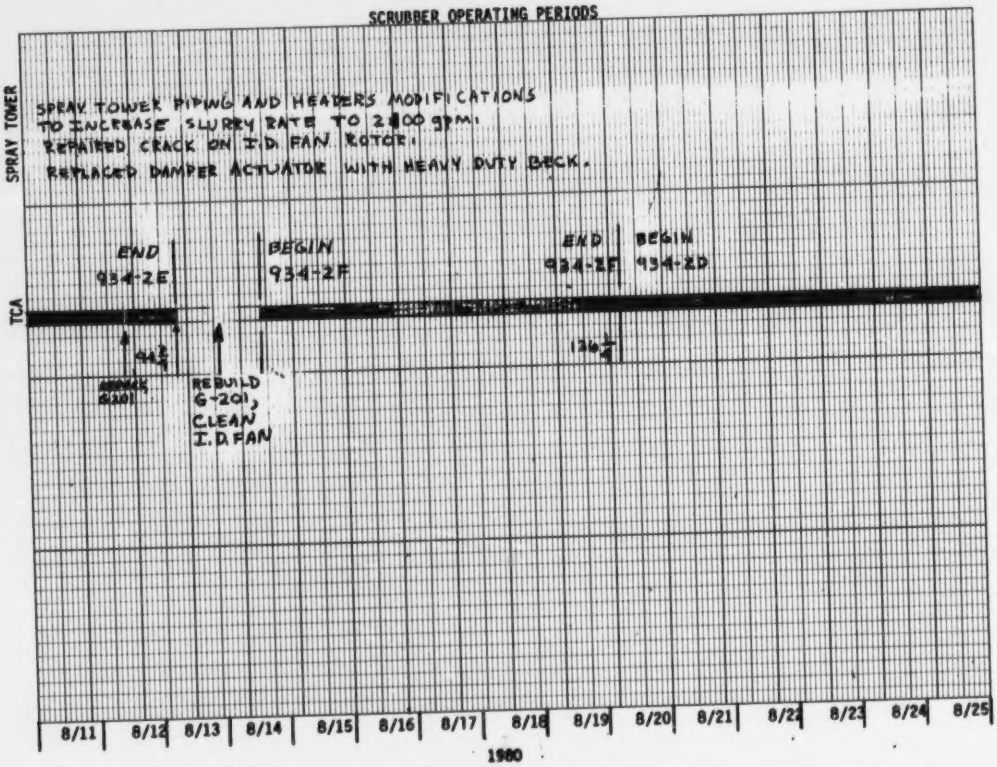

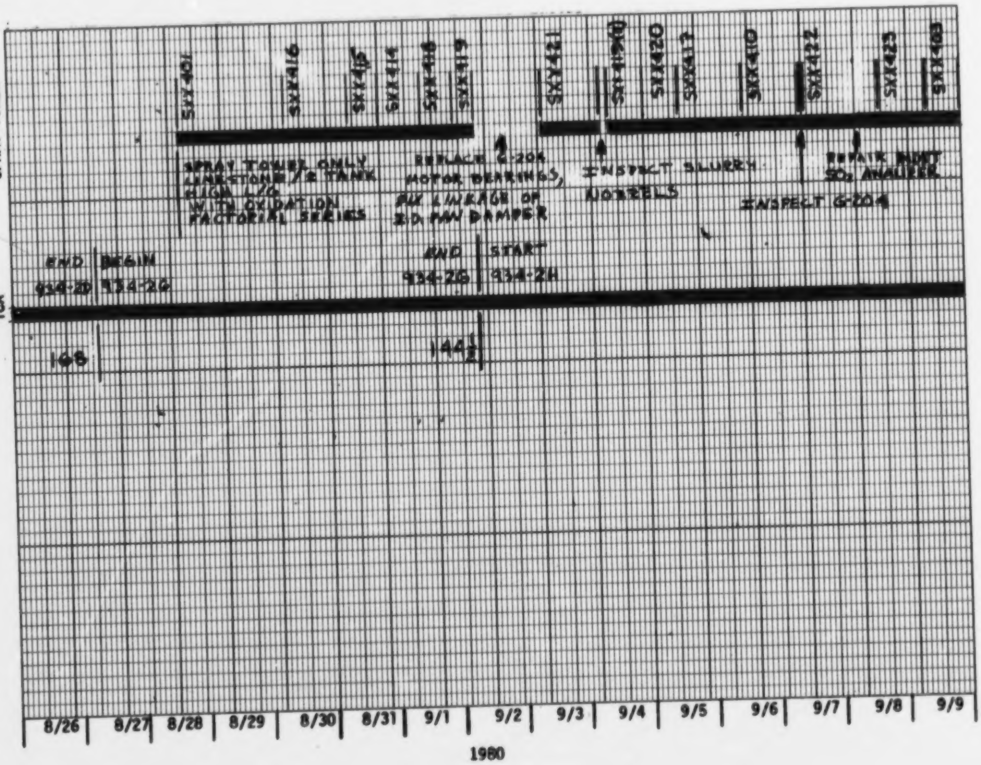

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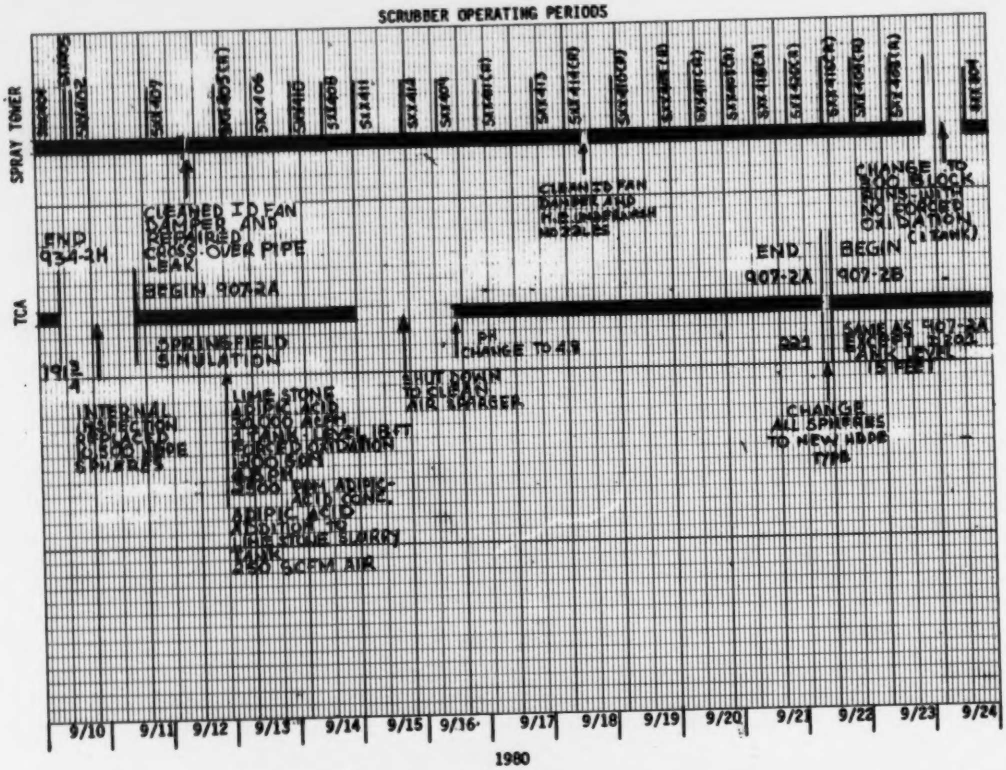

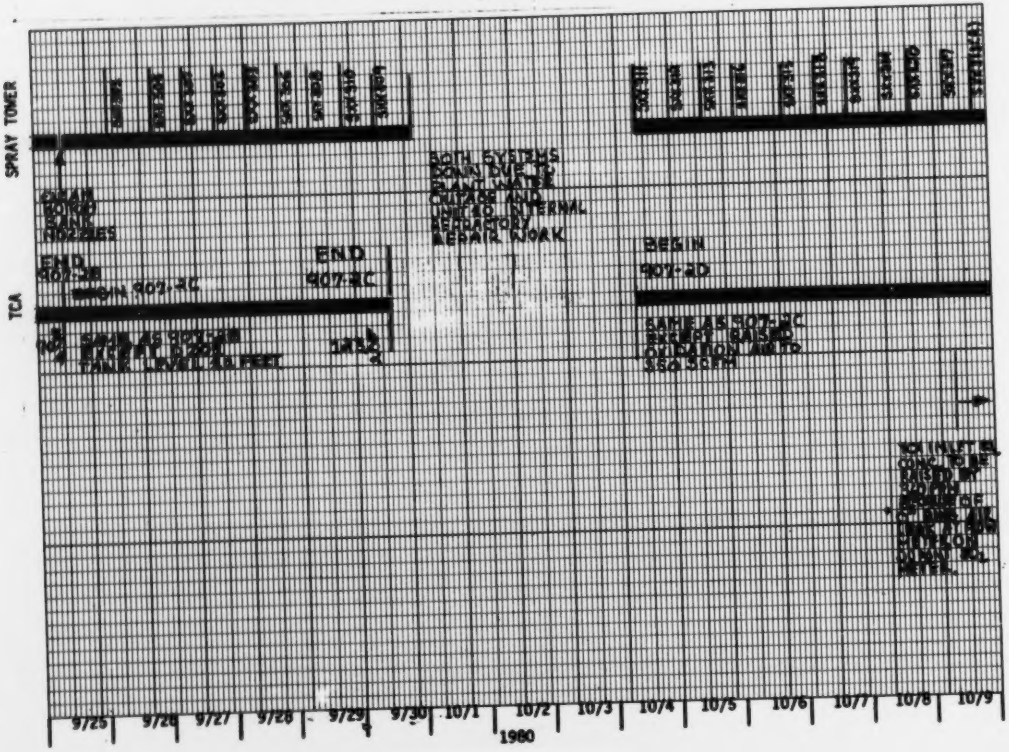

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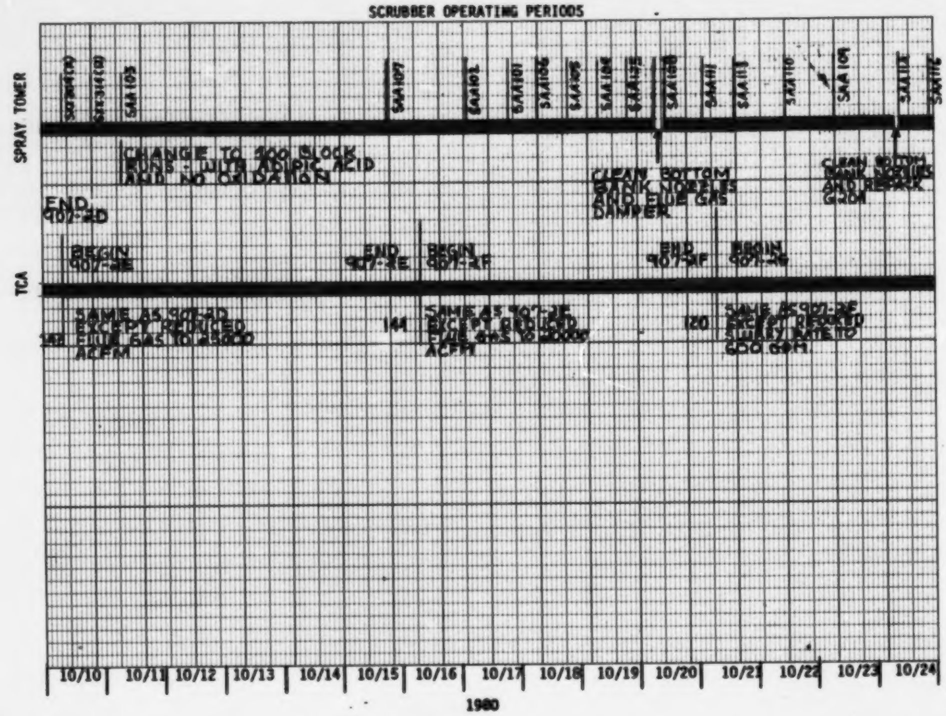

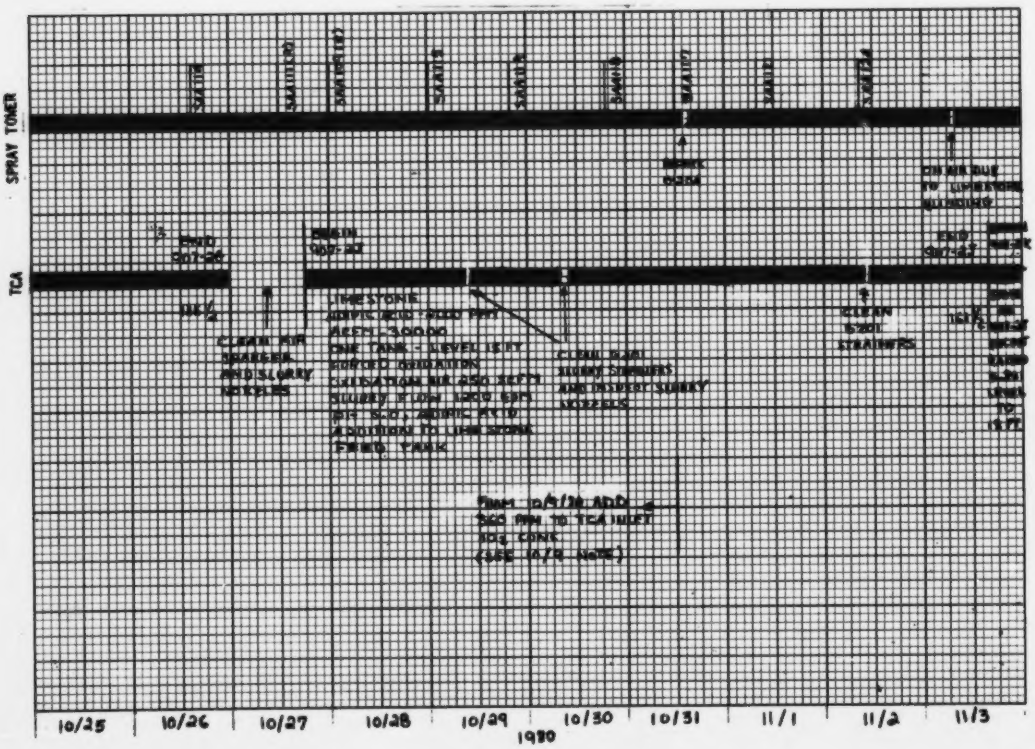

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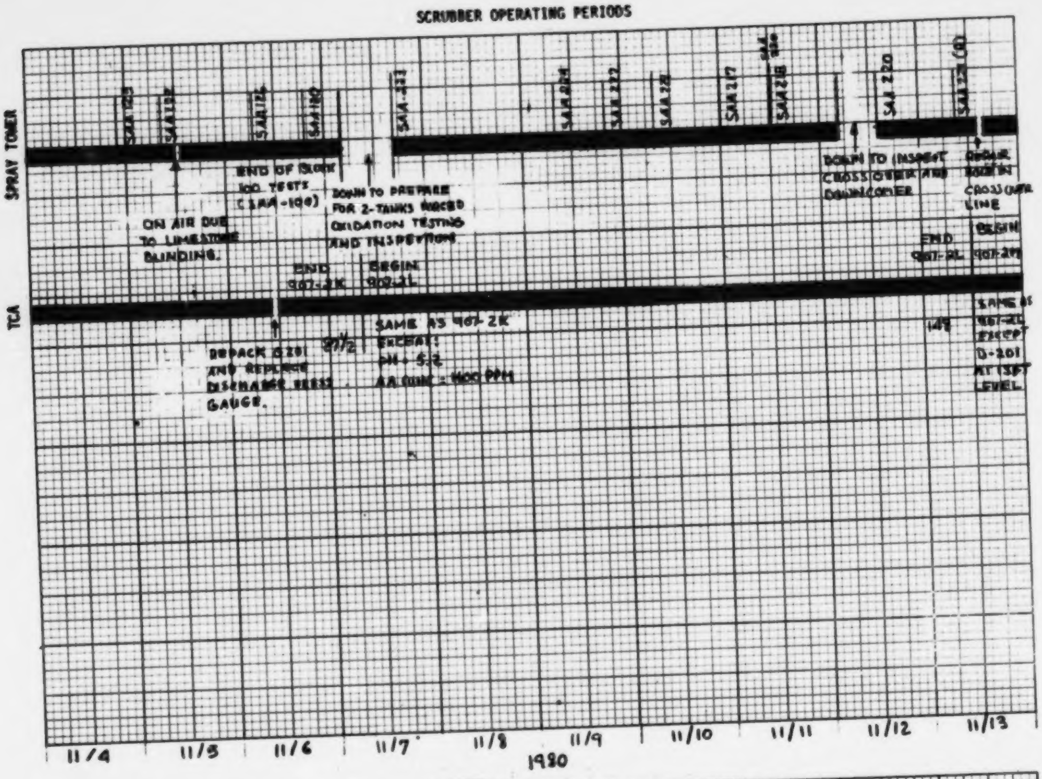

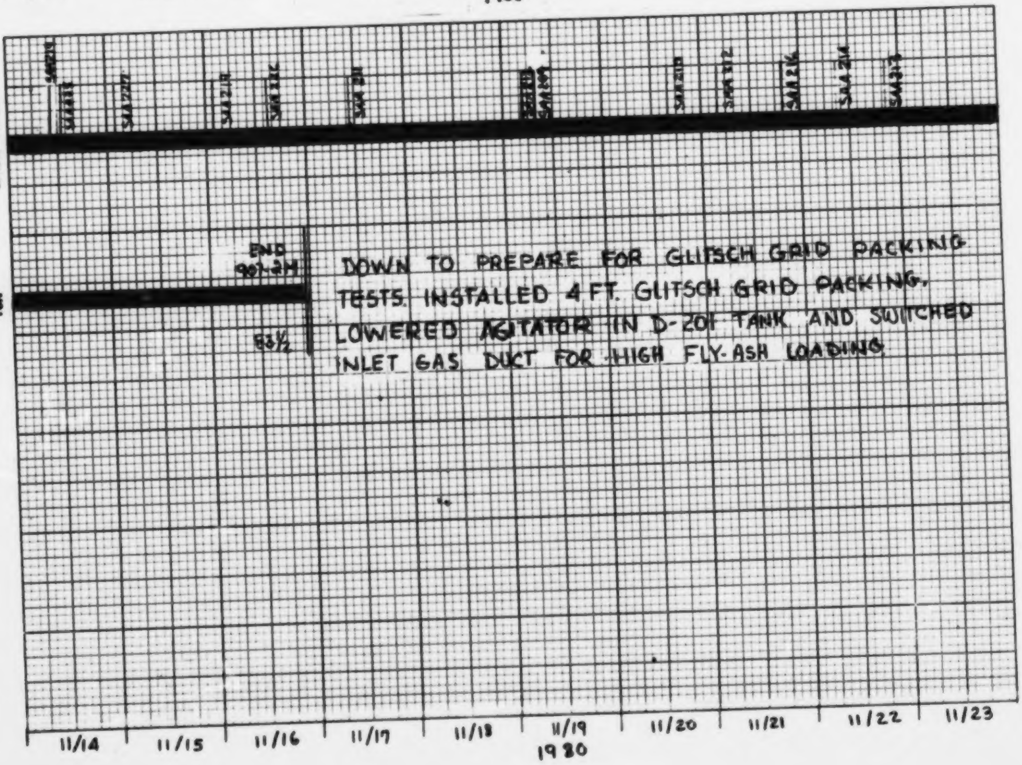

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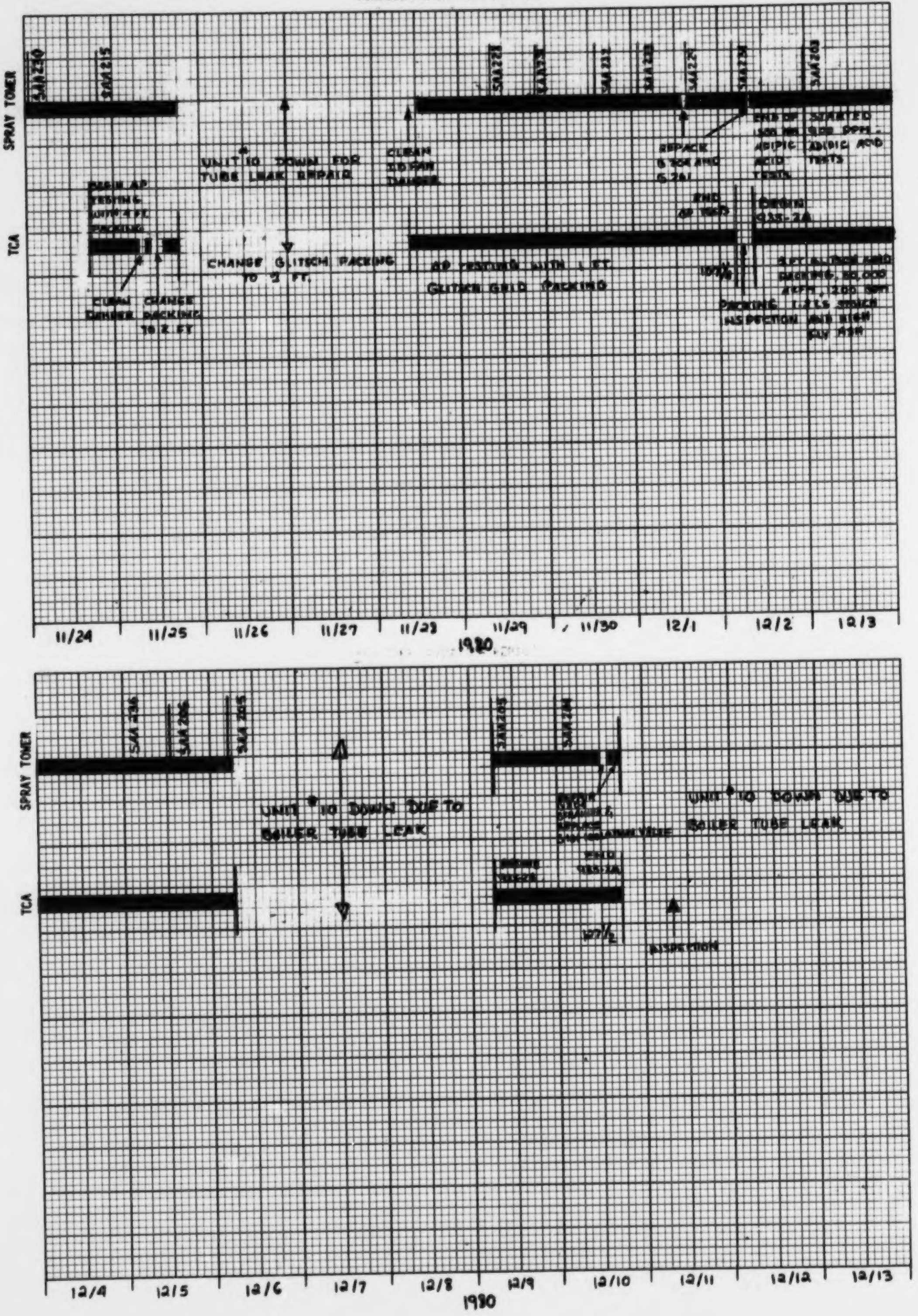

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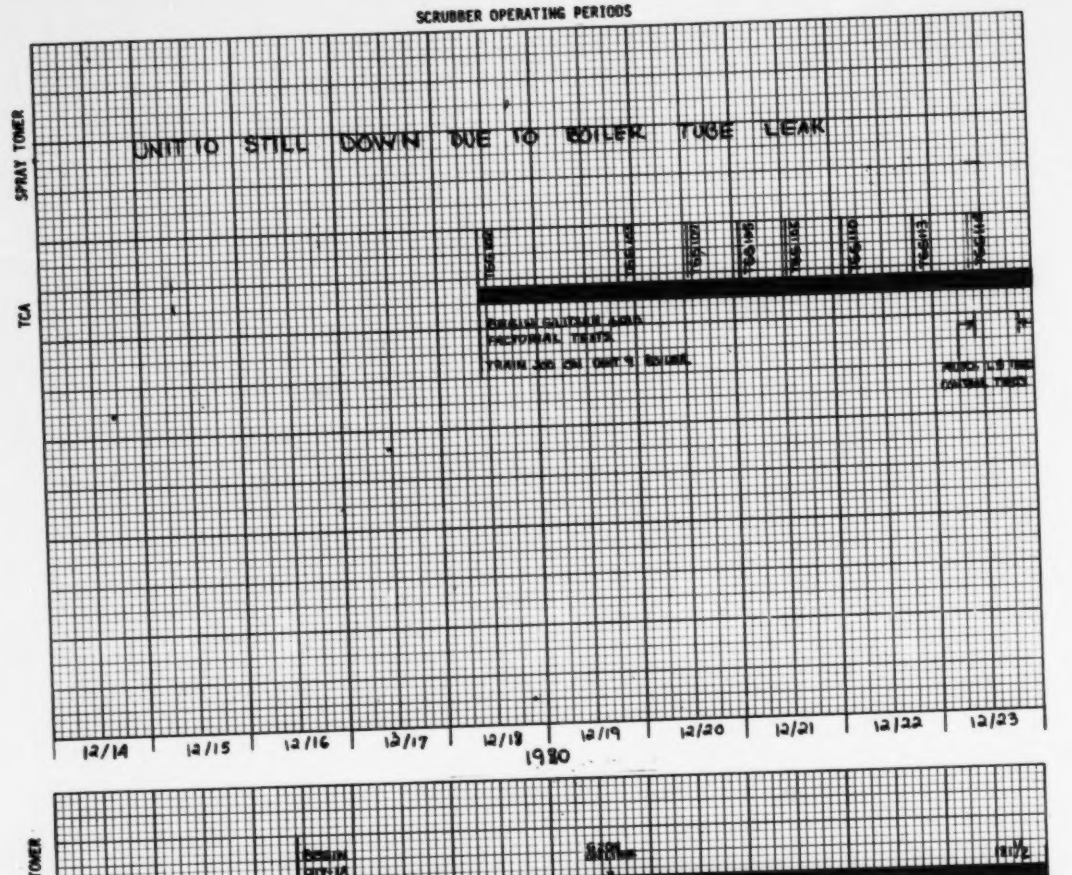

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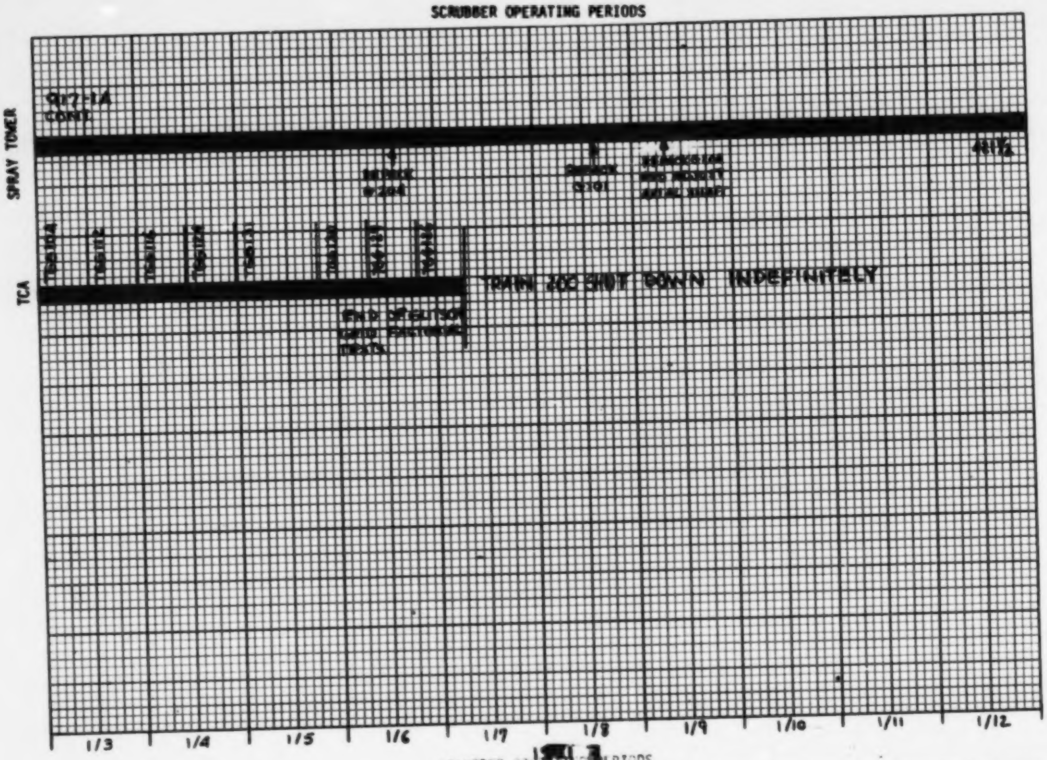

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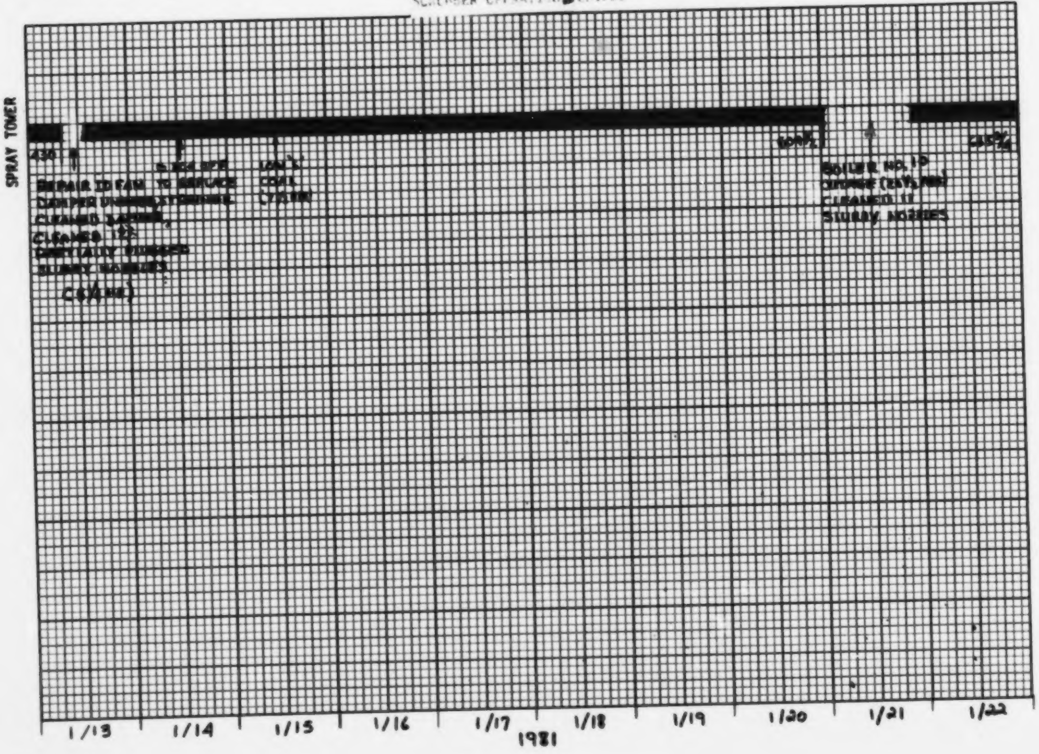

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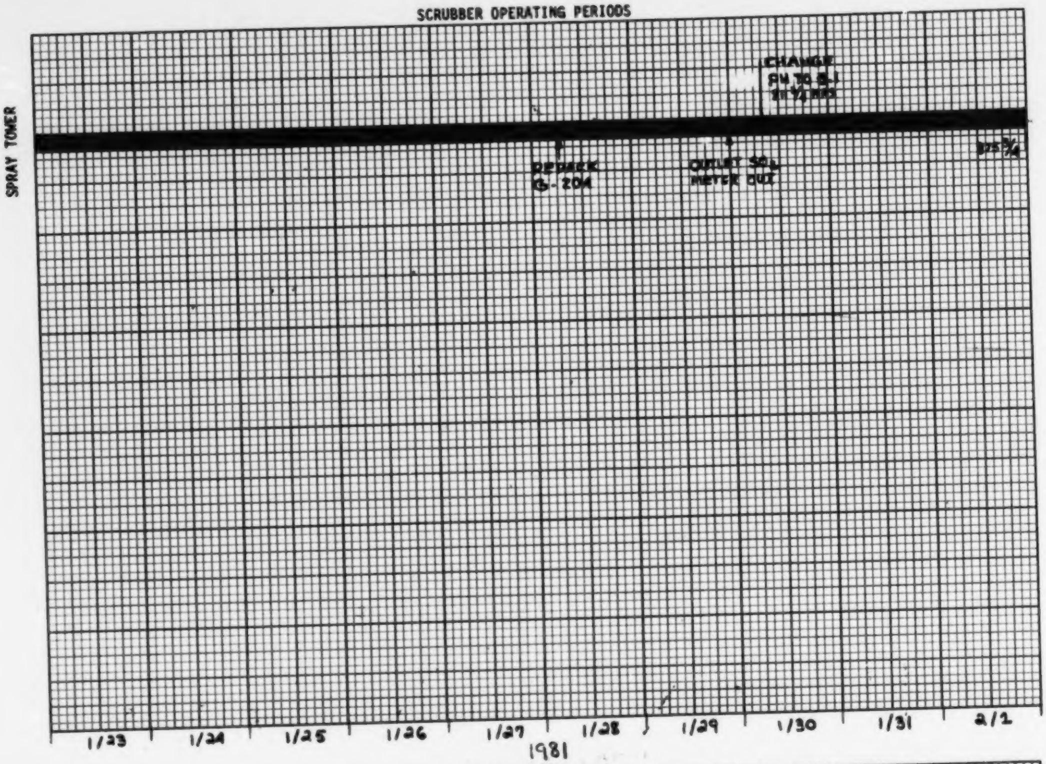

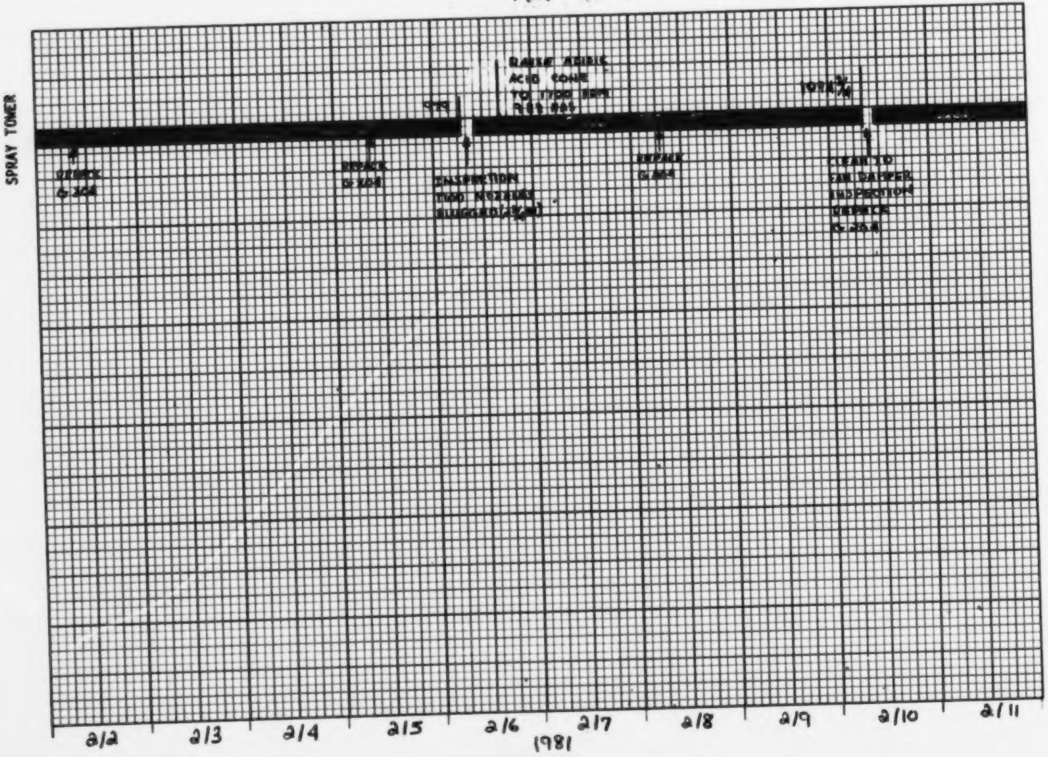

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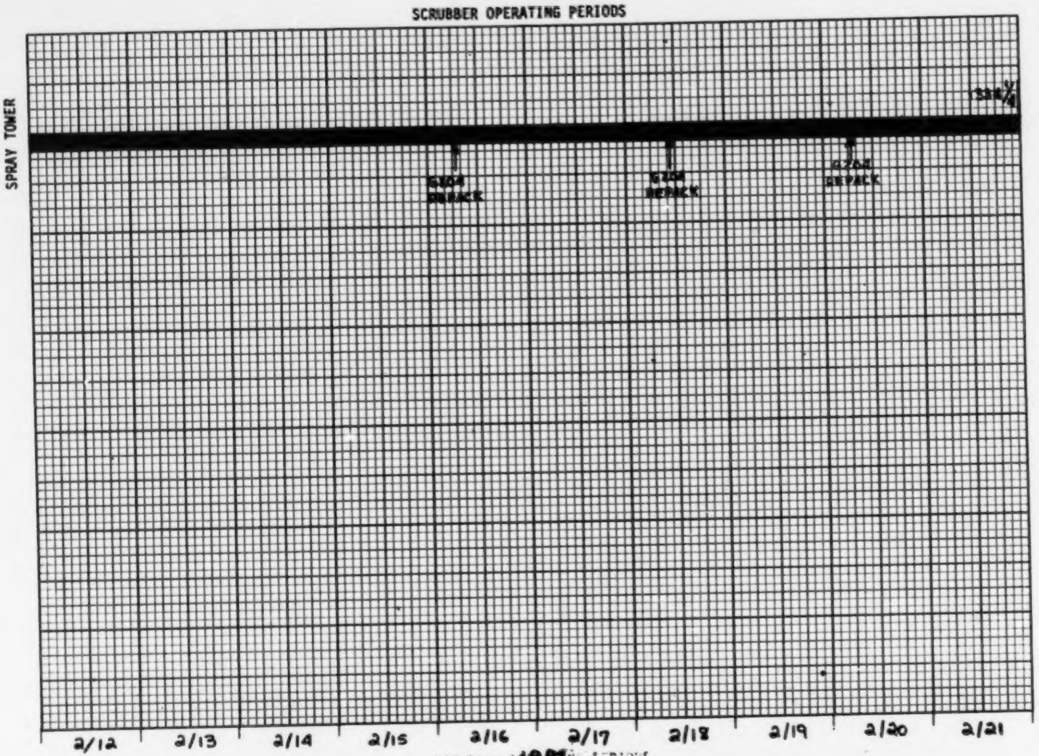

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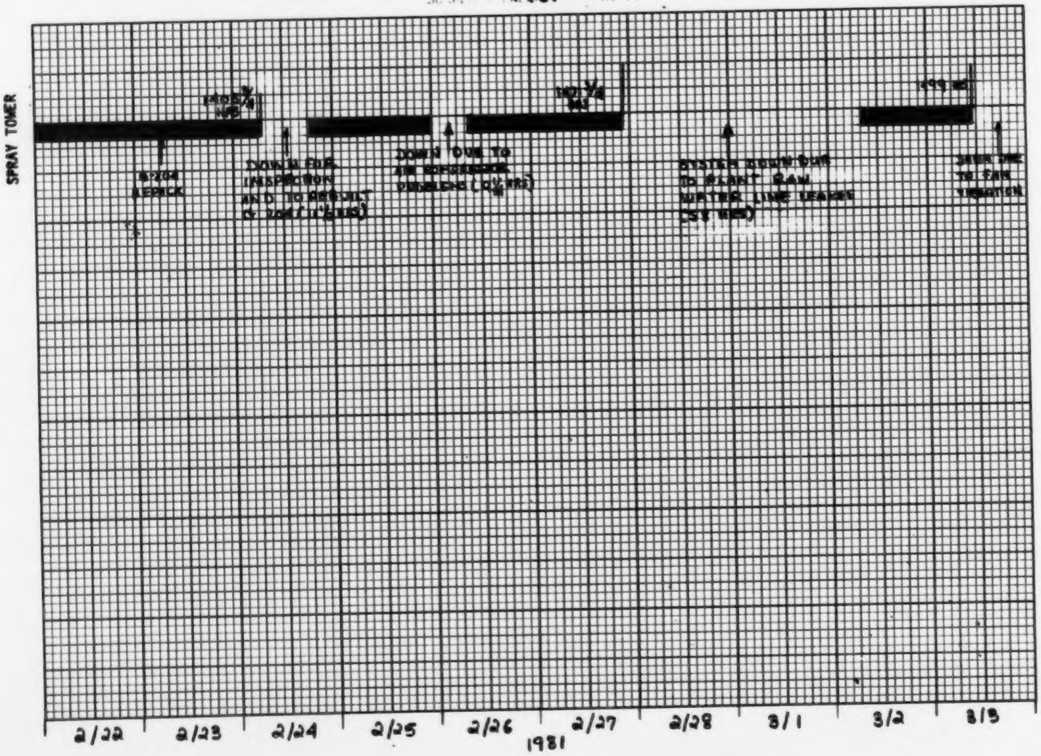

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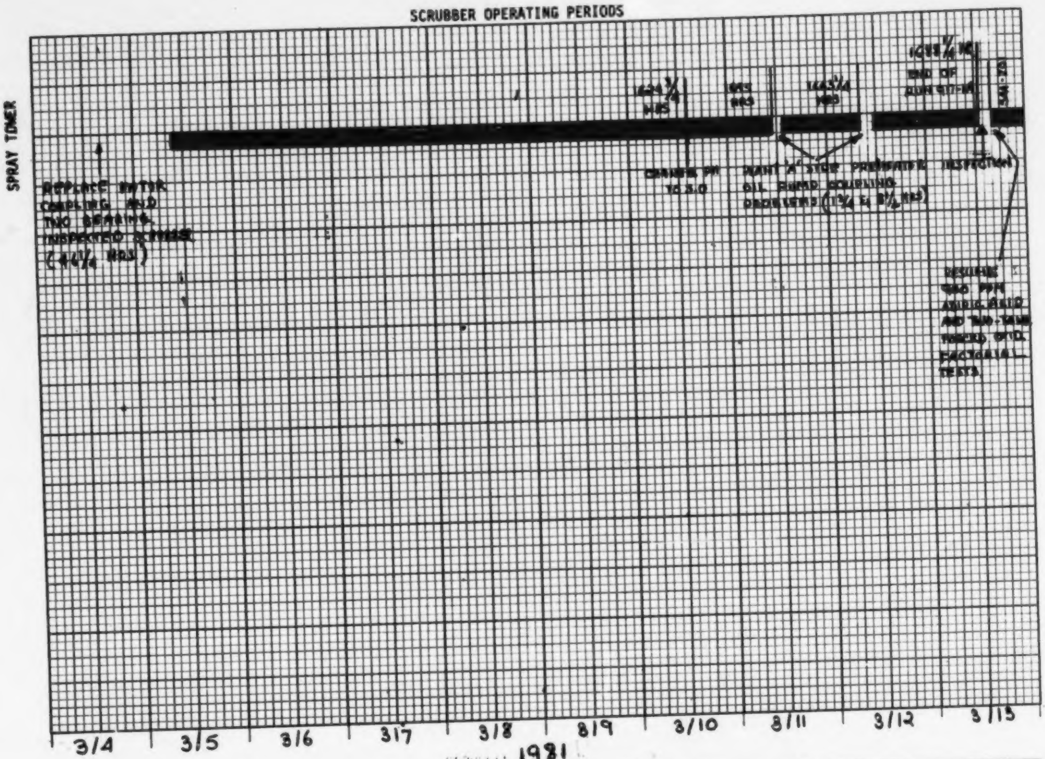

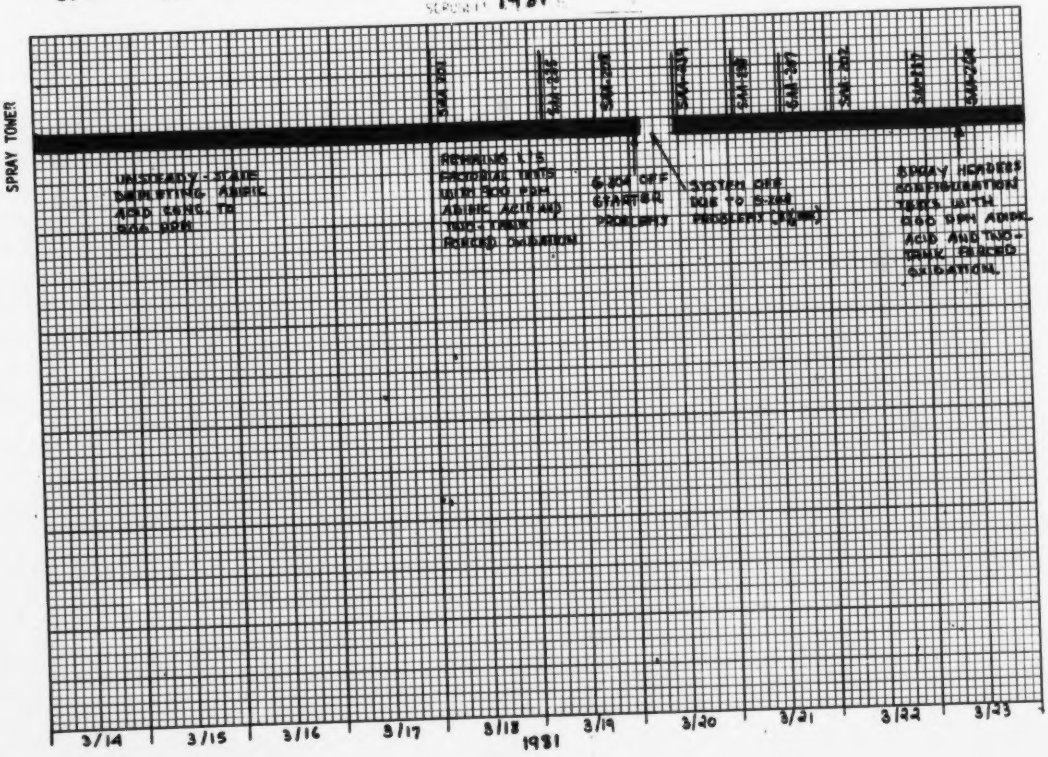

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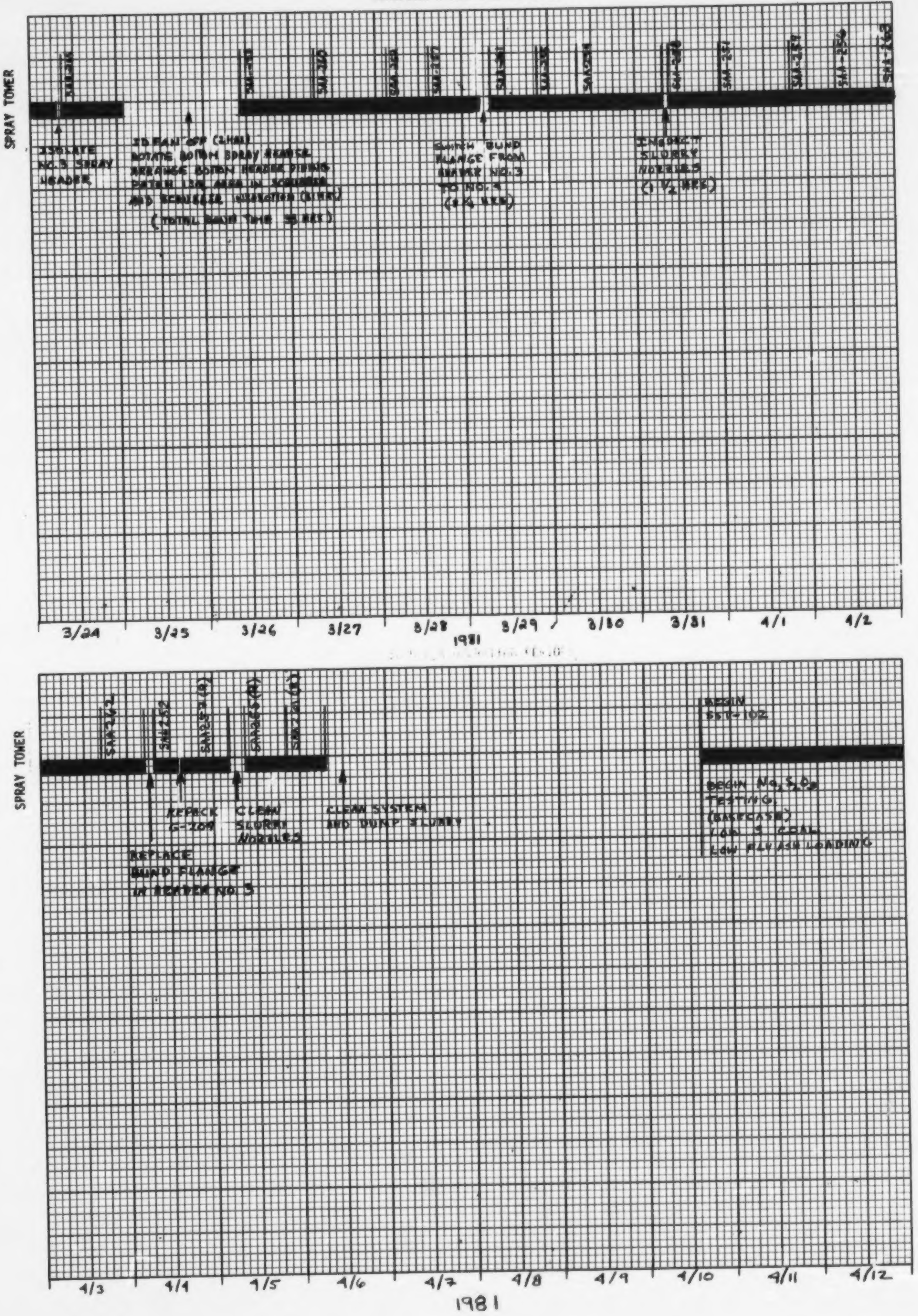

APPENDIX C

PROPERTIES OF RAW MATERIALS

The following is a summary of the properties of the raw materials used from July 1978 to March 1981.

C.1 COAL

Supplier (by mine): Numerous (Cary-Watts, Lost Spaniard, Vic, Alpha, Baizetown, South Hopkins, Pyro, Old Ben, Pittsburgh Midway, Robertson and Brown Badgett).

Type: Southern Illinois and Western Kentucky high sulfur

Analysis:

9.4	to	12.4	wt% total moisture
2.3	to	5.5	wt% sulfur
0.03	to	0.27	wt% chloride
13.0	to	16.3	wt% ash

Typical Ash Analysis:

54 wt%	SiO_2
23 wt%	AL_3O_3
12 wt%	Fe_2O_3
3 wt%	CaO
1 wt%	MgO
1 wt%	SO_3
3 wt%	K_2O
1 wt%	Na_2O
3 wt%	Ignition loss

C.2 LIMESTONE

C.2.1 Supplier: Fredonia Quarries, Fredonia, Kentucky

Type: Fredonia Valley White

Analysis

96.8 wt%	$CaCO_3$
0.9 wt%	$MgCO_3$
1.7 wt%	Inerts

Fine Grind:

91 wt%	less than 325 mesh
87 wt%	less than 30 microns
86 wt%	less than 27/25 microns
53 wt%	less than 6/5 microns

C.2.2 Supplier: Stone Man, Inc., Chattanooga, Tennessee

Type: Tiftonia

Analysis: 91.0 wt% $CaCO_3$
4.0 wt% $MgCO_3$
3.4 wt% Inerts

Grind: 87 wt% less than 325 mesh
96 wt% less than 200 mesh
76 wt% less than 30 microns
72 wt% less than 27/25 microns
67 wt% less than 20 microns
60 wt% less than 15 microns
49 wt% less than 10 microns
31 wt% less than 6/5 microns

C.3 LIME

Supplier: Mississippi Lime Co., Alton, Illinois

Type: Pebble Lime, unslaked

Analysis: 97.0 wt% CaO total
95.5 wt% CaO available
0.28 wt% MgO
0.47 wt% Inerts

C.4 ADIPIC ACID

Supplier: Various (Celanese, Du Pont, and Monsanto)

State: White, odorless, crystalline needles, dibasic acid

Molecular Weight: 146.14

Boiling Point @ 760 mm: 330°C

Melting Point: 152.1°C

Absolute Density (solids): 1.366 g/cc

Bulk Density: 40 lbs/ft^3, loose
50 lbs/ft^3, packed

Hygroscopicity: Non-hygroscopic at 27°C and 85% R.H.

Analysis: 99.6% min adipic acid
0.2% max water
10.0 ppm ash
1.0 ppm max iron as Fe

APPENDIX D

ANALYTICAL DATABASE SUMMARY

ANALYTICAL DATABASE SUMMARY

The NOMAD database system (National CSS, Inc.) has been used to store analytical data for the Shawnee Test Facility. This appendix presents the liquid and solid analytical data for runs performed from July 1978 through March 1981. Analytical data for factorial runs are not included.

The analytical point designations for slurries are as follows:

1805 = venturi/spray tower bleed stream oxidation tank
1815 = venturi inlet
1816 = spray tower inlet
1825 = spray tower outlet
1832 = venturi/spray tower oxidation tank (first of two series tanks)
1851 = venturi outlet
2816 = TCA inlet
2825 = TCA outlet
2832 = TCA oxidation tank (first of two series tanks)

The concentrations of Na^+ and K^+ were generally between 25 and 255 ppm during this period. The concentration of Fe and Mn was between 0.1 and 70 ppm.

Average, maximum, and minimum values for each run are from the entire run period. Analyses with liquid ionic imbalance greater than ± 20 percent or solid ionic imbalance greater than ± 8.5 percent are excluded.

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
827-1A	1815	855	735	1006	748	103	1238	102	23	520	3023	1652	3716	1235	222	2529			
	1816	933	750	1175	671	93	1118	627	113	1153	2753	1579	3645	1070	222	2130			
	1825																		
	1851	1051	840	1320	771	98	1255	709	45	1063	3167	1616	4347	1298	266	2574			
828-1A	1815	953	925	975	1191	1135	1253	113	90	136	3606	3442	3716	2618	2485	2840			
	1816	976	905	1040	1081	1040	1123	588	498	679	3303	3118	3535	2233	2041	2396			
	1825																		
	1851	1095	1050	1175	1177	1103	1235	784	679	905	3458	3256	3725	2603	2396	2929			
828-1B	1815	1094	1025	1185	1496	1355	1640	75	23	136	3495	3267	3762	3328	2663	3816			
	1816	1538	1065	1835	1292	1210	1460	2310	317	3415	3087	2384	4297	2773	2086	3373			
	1825																		
	1851	1368	1230	1575	1475	1340	1600	358	90	905	3866	3433	4298	3313	2751	3772			
829-1A	1815	1044	950	1240	1567	1303	1800	166	23	271	3850	3309	4593	3245	2973	3461			
	1816	1067	970	1355	1388	1180	1640	544	204	2081	3404	2751	3976	2909	2574	3328			
	1825																		
	1851	1262	1115	1510	1524	1330	1795	925	23	1696	3758	2803	4935	3225	2929	3461			
830-1A	1815	960	865	1320	1391	1075	1560	85	23	181	4135	3643	4602	2433	1864	2884			
	1816	933	830	1090	1244	1015	1385	230	136	362	3693	3195	4076	2159	1819	2751			
	1825	905	905	905	1315	1315	1315	317	317	317	3822	3822	3822	2485	2485	2485			
	1851	1175	1090	1360	1354	1055	1530	700	271	1131	4327	3667	5023	2460	1997	2929			
901-1A	1815	1337	1165	1520	786	585	995	79	23	158	2192	1637	2638	3205	2840	3861			
	1816	1221	1030	1350	461	311	589	510	136	1086	1958	1206	2514	1817	1243	2086			
	1825	1311	1095	1550	458	310	603	706	204	1357	2059	1391	2610	1826	1243	2130			
	1851	1427	1250	1615	824	610	1038	284	45	452	2585	1859	2896	3289	2796	3994			
902-1A	1815	1253	824	2320	1385	1010	1703	57	23	158	3434	2042	4881	2998	2986	5609	2651	1416	2688
	1816	1479	1035	1975	874	374	1070	1219	271	2737	2709	1601	3874	1621	533	2663	1460	858	1923
	1825	1550	1070	2075	841	395	1085	1448	407	2827	2729	2088	3735	1619	577	2645			
	1851	1326	796	2440	1384	998	1723	364	23	1040	3848	2177	5404	3059	2041	5946			
902-1B	1815	1699	1405	2190	1364	1175	1563	45	23	68	2353	1955	2719	4600	3816	6935	2354	1987	2560
	1816	1910	1780	2055	844	760	953	1070	927	1153	2389	1904	2946	2566	2396	2796	1596	1373	1873
	1825	1895	1740	2050	808	730	905	1185	973	1289	2169	1823	2701	2565	2441	2840			
	1851	1682	1360	2175	1351	1175	1535	297	90	588	2797	2455	3085	4746	3816	6301			
903-1A	1815	2490	2135	2755	1469	1343	1625	65	23	113	2256	1975	3473	5334	4704	6213	3510	3017	4061
	1816																		
	1825	1845	1785	1885	930	903	953	497	226	746	2231	2028	2469	3154	3018	3284			
	1851	2615	2255	2920	1453	1370	1605	764	136	1063	2792	2337	3305	5395	4793	6434			
904-1A	1815	2495	2365	2665	1369	1318	1500	58	23	90	2180	2062	2264	5169	4926	5591	3699	3117	4061
	1816																		
	1825																		
	1851	2628	2390	3100	1382	1248	1500	579	294	1357	2405	1546	2793	5258	4970	5680	3855	3632	4090

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH AVG	PH MIN	PH MAX	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
827-1A	1815	5.51	5.30	5.80	2936	1195	4854	98	81	118	8.8	-0.2	19.5
	1816	5.59	5.30	6.10	2653	1066	4373	100	89	135	9.4	0.4	20.0
	1825												
	1851	4.95	4.60	6.70	3096	1206	5132	114	103	132	7.1	-4.0	16.7
828-1A	1815	5.53	5.50	5.60	4889	4720	5180	95	95	96	0.2	-1.7	1.9
	1816	5.67	5.60	5.70	4326	4088	4511	95	87	102	2.5	-3.1	6.1
	1825												
	1851	4.97	4.90	5.00	4872	4621	5233	102	92	110	0.9	-0.1	2.7
828-1B	1815	5.28	5.20	5.30	6161	5313	6734	90	86	96	9.9	2.0	15.1
	1816	5.08	4.80	5.60	5377	4749	6184	109	96	155	9.9	6.4	13.2
	1825												
	1851	4.82	4.70	4.90	6335	5592	7005	117	98	132	9.7	7.3	15.4
829-1A	1815	5.55	5.30	5.70	6114	5582	6503	92	87	104	8.8	5.3	14.8
	1816	5.70	5.20	5.90	5509	4905	6077	90	75	102	8.9	-1.8	17.4
	1825												
	1851	4.97	4.60	5.30	6129	5584	6528	105	81	129	8.8	1.7	17.9
830-1A	1815	5.99	5.80	6.20	5032	3960	5681	99	90	135	8.7	0.0	15.1
	1816	6.09	5.80	6.35	4523	3882	5041	94	77	111	9.9	-1.9	15.8
	1825	6.30	6.30	6.30	4882	4882	4882	92	92	92	4.4	4.4	4.4
	1851	5.29	5.10	5.50	5114	4460	5833	122	102	145	5.7	-1.6	16.8
901-1A	1815	4.48	4.10	4.80	7885	7004	8648	93	85	103	1.9	-10.9	10.0
	1816	5.47	5.20	5.70	6121	4741	7197	99	69	117	-0.8	-11.6	8.9
	1825	5.48	5.00	7.30	6514	4955	7603	107	69	133	-3.6	-12.0	7.7
	1851	3.79	2.80	5.50	8707	7851	9551	111	93	124	-3.3	-14.0	4.7
902-1A	1815	4.33	3.40	5.10	11210	8245	14171	96	84	132	11.0	5.0	17.8
	1816	5.20	4.40	5.80	9525	6340	11942	114	68	167	2.2	-10.6	14.5
	1825	4.75	0.00	5.50	8368	6880	10052	120	90	164	9.5	-7.2	19.8
	1851	3.67	2.60	4.60	10357	8296	12958	112	90	151	8.7	-4.2	15.3
902-1B	1815	4.00	3.70	4.40	12761	11479	14370	89	85	101	10.6	7.0	15.8
	1816	5.03	4.90	5.20	10573	9802	11614	120	96	146	3.6	-3.5	8.1
	1825	5.02	4.90	5.20	8817	8214	9906	111	94	136	12.3	9.6	16.9
	1851	3.17	2.80	3.60	11137	9853	13078	101	95	116	4.5	-1.8	12.0
903-1A	1815	4.71	4.50	4.80	15522	13956	17113	104	94	151	12.3	3.2	18.1
	1816												
	1825	4.73	4.70	4.80	8887	8640	9012	107	98	118	16.3	15.8	17.1
	1851	4.39	4.30	4.50	13417	12391	14748	132	114	152	13.0	9.0	15.3
04-1A	1815	4.73	4.60	4.90	15363	14610	16552	104	101	109	11.6	6.4	15.9
	1816												
	1825												
	1851	4.39	4.30	4.50	15070	12223	18125	117	77	143	11.3	2.4	17.9

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
905-1A	1815	2963	2620	3460	1665	1510	1895	58	23	90	2177	1804	2632	7085	6568	7633	2317	1973	2588
	1816	2787	2260	3530	1054	910	1338	1925	113	2963	2348	1760	3266	4389	4260	4526	1410	1101	1716
	1825	2776	2350	3630	1039	928	1323	1804	90	2737	2423	1706	3470	4357	4216	4438	1410	1101	1716
	1851	3125	2480	3900	1682	1480	1880	601	271	973	2600	2400	3009	7220	6745	7810	2297	1973	2588
906-1A	1815	3392	2960	3820	1728	1525	1985	72	23	158	2290	2078	2520	8736	7366	9674	2496	2145	2831
	1816	2380	2160	2610	969	843	1130	701	317	1108	1979	1644	2225	4422	4083	5148	1485	1173	1773
	1825	2336	2130	2700	934	838	1070	784	430	1040	1894	1549	2307	4371	4083	4926	1485	1173	1773
	1851	3634	3360	4150	1743	1605	1880	834	543	1086	2446	2177	2679	8902	7526	9763	2496	2145	2831
907-1A	1815	3140	2070	4240	1066	593	1730	68	23	271	1868	677	2431	6537	4127	9585	2360	1888	3032
	1816	2332	1700	3120	638	385	973	403	68	905	1799	858	2603	3607	2485	4757	1559	1087	2431
	1825	2355	1760	2890	628	422	993	455	136	1063	1864	865	2819	3593	2574	4748	1558	1087	2431
	1851	3267	2170	4220	1067	513	1665	597	45	1312	1960	783	2928	6656	4083	9541	2362	1888	3032
907-1B	1815	2963	2040	4100	1284	793	2130	94	23	701	2045	1579	2832	6403	4038	8964	2160	1602	2803
	1816	2438	1325	3300	855	513	1485	541	93	1809	2045	1414	2885	4072	2485	5991	1509	1058	1859
	1825	2427	1370	3410	817	500	1380	640	113	2058	2060	1508	2927	3911	2529	6035	1513	1058	1859
	1851	3126	2000	4310	1275	690	2085	678	136	1380	2225	1187	3226	6451	3949	8742	2158	1602	2617
908-1A	1815	3880	3310	4500	2006	1870	2110	132	45	384	2171	1937	2465	9318	8653	9940	2221	2002	2374
	1816	2993	2710	3550	1279	653	1465	630	226	1131	2083	1533	3057	5774	5503	6213	1496	1401	1602
	1825	2981	2730	3720	1243	645	1460	563	271	1221	2177	1687	3252	5764	5547	6213	1518	1401	1602
	1851	4136	3790	4840	1959	1565	2175	742	498	1063	2250	1391	3096	9443	8609	10118	2221	2002	2374
909-1A	1805	1075	905	1395	585	510	680	68	9	271	2304	2089	2548	985	799	1154	1304	772	1630
	1816	1173	865	1485	561	127	660	561	54	2262	2342	1676	2995	969	311	1198	1292	315	1659
	1825	1210	1060	1525	571	470	670	652	158	2126	2332	1591	3006	953	754	1154	1445	1201	1659
	1851	1312	890	1805	585	126	1050	954	249	2759	2496	1923	3145	1065	311	2929	1273	257	1659
910-1A	1805	1108	635	1300	816	638	983	77	9	136	2638	2337	3078	1242	1065	1420	1469	1144	1859
	1816	1250	865	1360	816	663	945	535	154	1131	2758	2414	3163	1206	1065	1420	1535	1316	1830
	1825	1237	960	1415	793	653	935	479	149	959	2764	2371	3456	1184	1021	1376	1535	1316	1830
	1851	1467	1215	1615	818	685	945	1307	299	2126	2994	2474	3826	1232	1065	1464	1550	1430	1830
911-1A	1805	1314	1175	1480	957	823	1043	65	18	154	2642	2470	2878	1822	1243	2130	1667	1230	2202
	1816	1396	1200	1550	934	848	1048	445	217	751	2695	2286	2958	1795	1198	2041	1596	1430	1888
	1825	1420	1305	1675	929	838	1025	434	190	751	2721	2469	2969	1805	1198	1997	1603	1430	1888
	1851	1593	1430	1710	942	879	1068	1146	805	1484	2883	2662	3180	1828	1243	2041	1613	1430	1888
912-1A	1805	1306	1210	1370	1073	1020	1145	93	36	136	2989	2776	3124	1937	1775	2174	1654	1201	2002
	1816	1289	1130	1475	1051	968	1130	428	181	805	2998	2766	3172	1871	1686	2041	1554	1373	1716
	1825	1249	1125	1375	1044	980	1148	432	145	796	2910	2633	3074	1871	1686	1997	1554	1373	1716
	1851	1515	1290	1845	1052	985	1158	1170	380	1990	3217	2987	3360	1899	1731	2041	1556	1373	1716
913-1A	1805	1326	1255	1400	1096	1065	1140	83	54	127	3109	2856	3545	2115	1953	2219	1487	1430	1516
	1816	1410	1320	1495	1101	1040	1155	597	335	868	3057	2911	3247	2056	1864	2174	1525	1401	1716
	1825	1411	1340	1475	1102	1095	1110	612	326	923	3046	2888	3161	2085	1908	2174	1525	1401	1716
	1851	1672	1565	1780	1107	1070	1145	1271	1077	1466	2954	2624	3284	2019	1908	2130	1558	1401	1716

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH AVG	PH MIN	PH MAX	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
905-1A	1815	4.53	4.30	4.60	16755	15509	18298	105	91	131	12.8	7.5	18.9
	1816	4.73	4.50	5.00	14187	12839	16685	131	101	200	0.9	-5.9	12.4
	1825				14089	12995	16366	135	98	195	6.3	-4.2	18.6
	1851	4.21	3.80	4.70	18040	17257	19755	128	109	159	8.9	-4.4	16.8
906-1A	1815	4.53	4.40	4.70	19152	17140	21124	115	105	123	3.5	-3.6	10.8
	1816	5.17	4.80	5.40	12215	11018	14296	106	93	118	3.4	-1.7	10.8
	1825				12080	10987	13760	103	83	127	10.1	2.0	17.2
	1851	4.17	3.80	4.30	20588	18627	22165	129	119	139	2.8	-2.1	7.9
907-1A	1815	4.67	4.10	5.40	15416	11495	20931	110	50	153	5.5	-3.9	15.7
	1816	5.46	5.00	5.90	10550	8255	13293	110	56	170	3.4	-7.5	15.8
	1825	5.32	4.90	5.80	10659	8352	13140	115	56	161	3.1	-8.6	17.4
	1851	4.23	3.40	4.70	16290	11385	20767	117	58	167	3.3	-4.9	17.5
907-1B	1815	4.65	4.30	5.30	15354	10986	19605	110	82	155	9.1	-4.1	19.2
	1816	5.34	5.00	6.00	11696	7980	15352	116	76	162	4.6	-6.8	14.8
	1825	5.21	4.80	5.70	11595	8385	15635	118	78	156	7.6	-9.7	19.8
	1851	4.15	3.30	4.80	16321	11789	20912	123	72	168	7.0	-5.4	17.7
908-1A	1815	4.71	4.40	4.90	20226	19230	21525	112	99	132	12.2	6.5	14.8
	1816	5.29	5.10	5.50	14552	13338	16287	113	85	177	8.9	0.8	13.5
	1825				14535	13666	16603	119	94	193	14.8	4.5	19.4
	1851	4.31	4.00	4.50	21233	20001	21932	121	79	157	10.3	5.6	14.7
909-1A	1805	6.17	5.10	7.70	4078	3472	4637	98	85	122	11.2	4.4	16.7
	1816	5.51	4.70	6.20	4004	1610	4713	107	83	138	8.2	-3.2	18.7
	1825	5.42	4.60	5.90	4179	3562	4660	107	83	146	8.7	-2.2	16.7
	1851	4.90	3.60	5.60	4169	1567	6207	118	92	163	9.1	-1.7	19.9
910-1A	1805	6.79	5.50	7.20	4800	4000	5608	97	68	112	12.9	-5.3	15.7
	1816	5.29	5.00	5.80	4867	4485	5354	109	91	123	13.4	-5.1	18.7
	1825	5.40	5.00	5.90	4823	4454	5295	110	96	137	12.2	0.5	17.9
	1851	4.73	4.50	5.00	4975	4569	5465	129	108	160	13.4	1.9	19.9
911-1A	1805	6.09	5.20	7.20	5953	4672	6798	101	94	112	14.1	9.0	16.4
	1816	5.40	5.10	5.70	5834	5003	6463	108	100	121	13.2	8.1	19.4
	1825	5.44	5.20	5.70	5874	4954	6443	110	103	125	13.0	7.8	19.0
	1851	4.93	4.60	5.20	5954	5053	6503	123	112	137	13.5	8.9	18.3
912-1A	1805	6.83	6.10	7.00	6181	5494	6633	106	101	114	12.4	5.4	15.5
	1816	5.40	5.10	5.60	5912	5454	6421	107	94	115	11.0	7.7	16.9
	1825	5.55	5.20	5.70	5859	5380	6364	102	95	110	10.2	5.5	15.1
	1851	4.87	4.80	5.00	6010	5524	6476	125	108	138	11.3	6.5	14.9
913-1A	1805	6.17	5.50	6.90	6212	6135	6284	111	101	130	10.6	9.4	12.8
	1816	5.20	5.00	5.50	6145	5762	6378	113	110	117	11.9	11.1	12.3
	1825	5.47	5.30	5.70	6179	5899	6387	113	111	117	10.3	7.3	13.7
	1851	5.05	5.00	5.10	6277	5947	6608	121	112	130	16.2	12.8	19.6

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
914-1A	1815																		
	1816	4151	3560	4825	749	560	865	1264	421	2325	1992	1513	2436	6092	4615	7721	3783	3960	5177
	1825	4203	3610	4975	730	520	850	1544	801	2646	2046	1625	2485	6116	4571	7721	3834	3060	5177
	1851																		
914-1B	1815																		
	1816	4550	4550	4550	655	655	655	271	271	271	1980	1980	1980	6035	6035	6035	4147	4147	4147
	1825	4840	4640	4840	633	633	633	633	633	633	1853	1853	1853	6124	6124	6124	4147	4147	4147
	1851																		
914-1C	1815																		
	1816	5350	4900	6175	820	750	913	861	475	1461	1584	1475	1759	8699	7633	9541	4147	3604	4776
	1825	5370	4975	6000	824	750	938	1119	611	2058	1531	1267	1819	8699	7810	9408	4147	3604	4776
	1851																		
915-1A	1815																		
	1816	3908	2625	4620	645	128	874	443	204	1027	1693	1489	2092	5649	1287	6834	3894	3546	4290
	1825	3945	2600	4480	649	135	884	642	136	1565	1839	1492	2772	5687	1331	7100	3894	3546	4290
	1851																		
915-1B	1805	3870	3840	3900	840	800	880	97	81	113	1507	1456	1559	6101	5813	6399	3932	3718	4147
	1816	3873	3660	4200	803	766	844	383	357	430	1642	1629	1664	6094	5680	6390	3918	3661	4147
	1825	3840	3560	4200	801	764	840	552	421	746	1617	1546	1674	6044	5707	6301	3918	3661	4147
	1851																		
915-1C	1815	4400	4400	4400	900	900	900	181	181	181	1439	1439	1439	6745	6745	6745	3718	3718	3718
	1816	4729	4000	5375	960	880	1068	1022	362	2569	1681	1476	2201	7443	6905	7899	4062	3689	4776
	1825	4735	4275	5250	946	860	1020	1271	565	3026	1665	1280	2110	7374	6834	7952	4076	3718	4862
	1805	4512	4200	4950	965	900	1043	127	45	339	1444	1328	1676	7413	7091	7943	4207	3747	4862
916-1A	1815																		
	1816	3814	2110	4710	627	168	900	361	36	905	1587	1309	1830	5250	1420	7100	4013	3604	4547
	1825	3710	940	4790	706	155	1300	949	195	1877	1910	1410	4431	5082	947	6967	3772	1401	4547
	1832	3803	2340	4790	626	165	880	447	32	995	1727	1282	2067	5269	1420	7029	4051	3632	4433
916-1B	1815																		
	1816	4255	3750	4500	853	608	900	76	23	240	1488	1322	1679	6835	6213	7278	3988	3518	4433
	1825	4219	4000	4525	843	768	925	444	317	823	1695	1519	1848	6805	6168	7278	3988	3518	4433
	1832	4350	4075	4525	869	828	925	118	18	394	1690	1599	1778	6832	6186	7304	3893	3546	4204
916-1C	1815																		
	1816	3380	2950	3870	740	665	810	136	9	565	1579	1445	1739	5669	5059	6079	2376	1637	3346
	1825	3485	3100	3990	743	653	813	587	50	1063	1734	1559	2101	5638	5088	6035	2484	1630	3346
	1832	3401	3000	3820	742	648	845	246	23	656	1742	1539	2062	5629	5000	6124	2359	1659	3260
916-1D	1815																		
	1816	3330	2910	3780	709	610	885	66	0	289	1567	1379	1812	5770	5014	6727	1511	1344	1745
	1825	3401	2970	3950	694	600	870	461	271	864	1722	1596	2046	5768	5059	6656	1515	1344	1745
	1832	3396	3010	3930	713	613	908	131	18	493	1778	1568	2064	5798	5059	6878	1506	1201	1830

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH			TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
914-1A	1815												
	1816	4.61	4.30	5.00	14754	12358	17683	143	111	167	6.9	1.5	15.9
	1825	4.52	4.20	4.80	14804	12360	17737	148	122	176	6.2	0.4	12.1
	1851												
914-1B	1815												
	1816	5.10	5.10	5.10	15545	15545	15545	150	150	150	9.7	9.7	9.7
	1825	4.80	4.80	4.80	15821	15821	15821	144	144	144	14.8	14.8	14.8
	1851												
914-1C	1815												
	1816	4.60	4.50	4.70	19119	17691	21258	122	114	130	6.7	2.0	13.3
	1825	4.47	4.30	4.60	19086	17589	21047	118	94	140	7.6	2.2	14.9
	1851												
915-1A	1815												
	1816	4.98	4.40	5.20	14217	7746	16344	125	110	167	6.1	2.1	10.8
	1825	4.66	4.10	4.90	14255	7664	16316	135	111	191	7.5	-1.9	19.2
	1851												
915-1B	1805	5.70	5.40	6.00	14978	14392-	15565	104	102	107	5.2	3.1	7.2
	1816	5.10	5.00	5.20	14846	14014	15691	114	110	117	5.0	1.3	7.5
	1825	4.77	4.70	4.80	14725	14018	15362	112	104	117	7.6	1.6	11.8
	1851												
915-1C	1815	5.10	5.10	5.10	15981	15981	15981	103	103	103	13.0	13.0	13.0
	1816	4.77	4.44	5.05	17277	16202	18528	120	106	162	9.6	0.6	16.5
	1825	4.55	4.25	4.76	17168	15970	18807	119	95	154	11.1	6.1	17.6
	1805	4.92	4.60	5.26	17380	16361	18602	102	94	115	10.5	3.5	17.0
916-1A	1815												
	1816	4.79	4.37	5.08	13847	7350	16857	117	98	136	10.8	3.2	17.3
	1825	4.53	4.27	4.80	13865	6760	16639	122	108	145	10.9	-1.6	18.4
	1832	4.65	4.02	4.90	13881	7706	16873	127	94	156	10.8	8.0	16.1
916-1B	1815												
	1816	4.80	4.70	4.94	16201	15303	16896	106	95	121	10.9	-4.2	17.8
	1825	4.55	4.36	4.70	16047	15038	16680	120	109	130	9.7	3.1	16.2
	1832	4.77	4.61	4.98	16216	15270	16720	120	115	126	11.7	1.4	17.5
916-1C	1815												
	1816	4.84	4.44	5.05	12385	10542	14192	107	96	120	9.2	4.3	14.2
	1825	4.50	4.33	4.70	12478	10603	14214	118	104	143	9.8	3.2	13.0
	1832	4.67	4.45	4.90	12318	10664	13990	118	106	137	9.2	0.8	13.2
916-1D	1815												
	1816	5.10	4.84	5.28	11587	10377	12973	107	94	125	9.1	4.0	16.1
	1825	4.80	4.49	5.02	11557	10458	12951	119	112	139	7.6	0.1	15.3
	1832	5.00	4.64	5.25	11664	10392	13171	122	108	139	8.3	4.2	16.6

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
916-1E	1815																		
	1816	3610	3230	4040	831	775	924	54	0	136	1656	1515	1827	6923	6390	7633	1538	1401	1716
	1825	3564	3050	3980	814	692	902	201	122	339	1833	1689	2018	6810	5769	7704	1537	1401	1716
	1832	3642	3250	4020	841	772	954	56	18	113	1768	1589	1983	6956	6434	7677	1555	1439	1802
916-1F	1815																		
	1816	4053	3750	4360	941	844	1025	474	27	769	2017	1820	2579	7242	6745	7677	1487	1287	1573
	1825	4188	3740	4470	939	874	998	1080	357	1488	2054	1659	2555	7303	6976	7659	1476	1287	1573
	1832	4161	3850	4400	940	850	990	649	118	1199	2079	1826	2572	7306	6923	7606	1496	1316	1687
916-1G	1815																		
	1816	3898	3780	4006	1014	973	1050	31	18	46	1820	1681	2027	7455	7233	7721	1528	1373	1830
	1825	4088	4030	4180	1009	965	1035	461	68	611	2079	1889	2522	7433	7278	7677	1530	1373	1830
	1832	3850	3290	4030	1021	988	1050	88	23	145	1981	1843	2174	7460	7233	7721	1511	1430	1773
916-1H	1815																		
	1816	3720	3180	4170	1061	978	1155	604	136	2556	1949	1755	2152	6968	5994	7810	1510	1316	1687
	1825	3789	3230	4475	1068	1028	1115	886	158	3121	2020	1758	2548	7173	6372	7810	1577	1373	1687
	1832	3799	3280	4280	1074	995	1150	911	113	2985	1978	1714	2458	7058	6079	7766	1463	1258	1659
917-1A	1815																		
	1816	1001	750	1295	1566	1045	1920	36		315	4000	2342	4941	1994	1243	2716	1524	1058	1945
	1825	1135	790	1345	1600	1030	2020	450	57	956	4167	3600	5665	2074	1278	2734	1543	196	1945
	1832	1097	775	1335	1651	1315	1965	58	11	182	4188	3661	5061	2186	1167	2769	1598	1087	1945
926-1A	1815																		
	1816	2914	2340	3380	1169	888	1505	1297	127	2443	2439	1546	3408	5178	4686	5645	3131	1888	4576
	1825	2988	2610	3430	1115	875	1270	1675	520	2529	2674	1765	3637	5044	4260	5615	2870	1888	3975
	1851																		
926-1B	1815																		
	1816	3036	2480	3540	1256	1120	1480	949	380	1900	2390	1733	3075	5881	4556	7011	1553	1087	2288
	1825	3156	2490	3560	1259	1075	1455	1519	669	2510	2460	1949	3319	5842	4526	6967	1553	1087	2288
	1851																		
926-1C	1815																		
	1816	3032	2770	3300	1281	1065	1410	599	113	2171	2370	1816	3293	6230	5769	6834	1315	944	1573
	1825	3153	2820	3680	1256	995	1350	977	90	2510	2562	2118	3276	6146	5636	6656	1315	944	1573
	1851																		
926-1D	1815																		
	1816	3198	2850	3580	1249	1045	1570	203	54	1153	1977	1490	2410	6710	5946	8076	1288	1030	1630
	1825	3200	2940	3540	1227	1050	1370	280	81	1538	2047	1515	2731	6731	5946	7810	1295	1030	1630
	1851																		
926-1E	1815																		
	1816	2780	2000	3320	972	660	1275	312	54	651	1984	1548	2265	5589	3609	7011	749	343	1901
	1825	2860	2090	3360	961	700	1160	671	181	1095	2152	1892	2486	5549	3580	6923	749	343	1901
	1851																		

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH			TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
916-1E	1815												
	1816	5.14	4.95	5.36	13203	12089	14576	112	103	122	4.5	1.3	7.1
	1825	4.89	4.65	5.12	12988	11209	14526	123	113	135	3.1	-1.1	9.5
	1832	5.10	4.85	5.30	13301	12156	14347	119	107	132	4.3	1.3	8.3
916-1F	1815												
	1816	5.20	5.00	5.44	13973	13137	14750	136	124	174	7.5	3.3	10.2
	1825	4.84	4.27	5.11	14011	13157	14713	140	118	173	7.1	0.3	10.9
	1832	5.10	4.80	5.38	14106	13316	14664	142	125	175	7.7	3.1	12.5
916-1G	1815												
	1816	5.36	5.31	5.41	14254	13946	14717	119	111	134	7.8	4.3	19.9
	1825	4.99	4.93	5.04	14317	14036	14607	139	126	169	8.4	5.6	13.4
	1832	5.24	5.20	5.26	14176	13473	14700	129	121	143	5.9	-4.5	11.6
916-1H	1815												
	1816	5.20	4.83	5.75	13505	11872	14395	124	111	145	8.3	-1.8	18.2
	1825	4.80	4.57	5.24	13802	12320	14574	129	109	161	6.9	-1.1	11.7
	1832	4.86	4.56	5.58	13581	11740	14293	126	112	154	8.7	-0.9	13.7
917-1A	1815												
	1816	5.06	4.86	5.31	12575	9865	15539	93	60	133	6.7	-12.2	18.0
	1825	4.67	4.06	4.88	13527	10713	16178	105	88	135	7.1	-4.4	18.9
	1832	4.87	3.58	5.09	13366	10241	15757	100	90	113	7.7	-4.3	19.1
926-1A	1815												
	1816	4.66	4.40	5.50	12399	10261	14497	133	87	184	4.8	-2.5	15.0
	1825	4.32	4.10	4.70	11940	9999	13848	149	101	198	5.6	-2.7	13.2
	1851												
926-1B	1815												
	1816	4.83	4.60	5.10	11781	9551	13548	130	94	164	8.2	1.7	12.9
	1825	4.48	4.30	4.80	11747	9437	13518	136	103	179	8.9	1.7	16.8
	1851												
926-1C	1815												
	1816	5.01	4.50	5.30	11998	10991	13053	128	99	174	7.1	-0.6	12.9
	1825	4.65	4.50	5.00	11930	10908	13029	141	119	181	7.3	-0.2	14.5
	1851												
926-1D	1815												
	1816	5.45	5.00	5.60	12652	11096	14795	112	85	137	7.6	4.0	11.8
	1825	5.00	4.70	5.10	12639	11062	14267	116	84	155	7.3	1.6	13.4
	1851												
926-1E	1815												
	1816	5.06	4.90	5.30	10227	6773	12761	114	89	129	6.3	-6.5	10.6
	1825	4.65	4.50	4.90	10182	6776	12350	125	116	139	5.6	-6.4	12.1
	1851												

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
926-1G	1815																		
	1816	2883	2530	3400	1352	1175	1600	769	204	1583	2543	2040	3304	5628	4645	6568	2621	1945	4347
	1825	3000	2680	3390	1329	1103	1605	1307	511	2420	2583	1918	3640	5629	4633	6372	2635	1945	4347
	1851																		
926-1H	1815																		
	1816	3318	2940	3930	1196	1060	1465	186	90	470	2060	1853	2275	6545	5813	7366	1294	1058	1516
	1825	3300	2910	3910	1162	1050	1300	313	145	995	2188	1726	2700	6525	5858	7366	1296	1058	1516
	1851																		
927-1A	1815	2501	2210	2860	873	770	1105	298	127	543	1946	1750	2398	4776	4083	5591	784	744	858
	1816																		
	1825	2665	2320	2930	905	755	1170	706	362	1153	2136	1788	2472	4906	4171	5680	791	744	858
	1851																		
927-1B	1815	2990	2800	3100	908	900	920	372	262	470	1932	1815	2070	5753	5591	6079	724	658	772
	1816																		
	1825	3010	2800	3320	903	803	1005	852	715	1004	2027	1985	2089	5665	5325	5991	724	658	772
	1851																		
927-1C	1815	2876	2740	3080	881	850	908	372	204	498	1960	1805	2134	5431	5148	5769	1320	944	1602
	1816																		
	1825	2993	2650	3180	853	755	893	952	520	1176	2175	1811	2700	5311	4793	5680	1320	944	1602
	1851																		
927-1D	1815	3626	3540	3760	964	950	985	252	161	398	1822	1748	1959	7144	6967	7411	1344	1316	1401
	1816																		
	1825	3610	3500	3720	969	958	975	495	289	738	1932	1893	2006	7248	7100	7455	1344	1316	1401
	1851																		
927-1E	1815	3610	3500	3920	926	903	958	306	81	742	1954	1779	2112	6035	5769	6479	3301	2116	4004
	1816																		
	1825	3606	3400	3690	933	900	978	624	244	1538	2199	1769	2638	6133	5769	6523	3301	2116	4004
	1851																		
927-1F	1815	3530	3300	3830	911	895	930	354	226	461	1938	1903	1992	5762	5529	6079	3918	3747	4033
	1816																		
	1825	3503	3370	3730	889	845	913	918	878	973	1964	1922	2043	5783	5591	6079	3918	3747	4033
	1851																		
927-1G	1815	3890	3880	3900	906	893	920	352	235	470	1974	1818	2130	6168	6035	6301	4004	3975	4033
	1816																		
	1825	3785	3770	3800	839	825	853	1038	838	1239	2133	1967	2299	5991	5769	6213	4004	3975	4033
	1851																		
927-1H	1815	3740	3740	3740	920	920	920	485	485	485	1890	1890	1890	6079	6079	6079	4004	4004	4004
	1816																		
	1825	3770	3770	3770	945	945	945	1227	1227	1227	2161	2161	2161	6142	6142	6142	4004	4004	4004
	1851																		

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH			TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
926-1G	1815												
	1816	4.82	4.60	5.00	12593	11336	14790	131	106	167	7.0	-0.5	12.8
	1825	4.52	4.30	4.80	12590	11265	14579	137	100	186	7.4	-0.8	14.4
	1851												
926-1H	1815												
	1816	5.24	5.00	5.50	12562	11292	14210	120	106	134	9.8	5.7	17.0
	1825	4.83	4.50	5.10	12464	11289	13717	128	99	159	8.6	1.2	12.1
	1851												
927-1A	1815	5.26	5.00	5.50	9081	8102	10312	111	96	133	7.5	4.6	9.8
	1816												
	1825	4.77	4.50	5.00	9329	8328	10536	123	99	147	7.2	5.3	11.6
	1851												
927-1B	1815	5.17	5.10	5.20	10533	10215	10873	118	113	123	6.9	3.2	11.6
	1816												
	1825	4.67	4.60	4.80	10353	10053	10893	124	116	133	5.6	-1.9	11.5
	1851												
927-1C	1815	5.15	5.10	5.20	10668	10183	11290	118	108	128	4.6	1.9	5.9
	1816												
	1825	4.58	4.50	4.70	10508	9649	11190	134	112	165	4.4	2.3	7.2
	1851												
927-1D	1815	5.17	5.10	5.30	13280	13011	13682	118	113	127	4.1	3.4	4.6
	1816												
	1825	4.73	4.50	4.90	13339	13081	13662	125	123	128	2.5	1.5	3.1
	1851												
927-1E	1815	5.12	4.90	5.30	14058	13165	14934	127	117	142	5.0	1.1	8.0
	1816												
	1825	4.66	4.30	4.90	14094	13059	14764	142	117	171	4.6	-1.3	8.0
	1851												
927-1F	1815	5.10	5.10	5.10	14294	13641	14976	126	121	129	3.4	2.3	5.6
	1816												
	1825	4.57	4.50	4.60	14149	13594	14775	128	124	135	4.6	3.0	5.5
	1851												
927-1G	1815	5.05	5.00	5.10	15137	15083	15191	133	124	143	5.4	4.7	6.0
	1816												
	1825	4.50	4.50	4.50	14644	14485	14803	145	135	155	4.5	2.5	6.5
	1851												
927-1H	1815	5.10	5.10	5.10	14904	14904	14904	126	126	126	3.8	3.8	3.8
	1816												
	1825	4.70	4.70	4.70	14848	14848	14848	142	142	142	2.6	2.6	2.6
	1851												

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RUN SUMMARY    -   LIQUID ANALYTICAL DATA

                                        CONCENTRATIONS IN LIQUID, PPM

       ANALY        CA++              MG++               SO3=                SO4=               CL-                AD=
RUN    TICAL
NO.    POINT AVG   MIN  MAX    AVG   MIN  MAX    AVG   MIN   MAX    AVG   MIN   MAX    AVG  MIN  MAX     AVG  MIN  MAX
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927-1I 1815  3393 3310 3500   1004   913 1050    519   449   656   1908  1840  1982   5991 5858 6213   3899 3804 4004
       1816
       1825  3450 3380 3520    967   905 1030   1034   935  1163   2169  1999  2339   5990 5946 6035   3847 3804 3890
       1851
927-1J 1815  3026 2810 3230    901   878  935    313   169   452   1872  1501  2187   6153 5769 6656    753  715  801
       1816
       1825  3220 2930 3500    906   875  945    653   534   746   2191  1777  2592   5857 5680 6079    753  715  801
       1851
927-1K 1815  3707 3500 3860    968   910 1050   1003   735  1131   2011  1686  2310   5990 5591 6434   4039 3918 4233
       1816
       1825  3842 3710 4070    930   885 1005   1746  1190  2081   2172  1744  2878   5948 5503 6461   4039 3918 4233
       1851
927-1L 1815  3725 3710 3740    911   848  975   1009   905  1113   1869  1811  1927   6101 6079 6124   4046 3975 4118
       1816
       1825  3940 3940 3940    815   785  845   1653  1497  1809   1996  1986  2007   6168 6079 6257   4046 3975 4118
       1851
927-1M 1815  3856 3440 4320    759   608  838    244    16  1357   1547  1452  1753   5453 4615 5858   4091 3632 4547
       1816
       1825  4018 3480 4440    739   638  855   1475   923  2872   1669  1472  1874   5427 4526 5813   4091 3632 4547
       1851
927-1N 1815  3825 3710 3940    761   760  763     44    20    68   1514  1425  1603   5931 5680 6183   3994 3718 4090
       1816
       1825  3810 3810 3810    728   728  728    769   769   769   1669  1669  1669   5680 5680 5680   3718 3718 3718
       1851
927-1O 1815  4263 3880 4500    797   703  853     38    14    90   1455  1309  1580   7234 6124 7988   4261 3918 4576
       1816
       1825  4328 4020 4650    796   655  898    536    34   751   1730  1508  2406   7235 6124 7899   4267 3918 4576
       1851
927-1P 1815  4491 3850 5125    759   583  975    572   204  2081   1739  1546  2371   6636 5591 7766   3863 3289 4290
       1816
       1825  4566 3925 5150    761   573  955    792   317  2262   1841  1585  2388   6699 5600 7854   3863 3289 4290
       1851
951-1A 1615  1424 1235 1700    290   121  452    125    45   339   1508  1274  1840   2139 1464 2663
       1816  1058  966 1280    156    47  265    111    23   204   1410  1156  1649   1131  666 1420
       1825  1256 1060 1835    164    69  263    639   249  1018   1579   914  2033   1139  621 1420
       1851  1665 1480 2000    290   147  488    651   181  1086   1716   971  2313   2161 1598 2663
952-1A 1815  1292 1105 1615   1008   795 1265    109    45   204   2624  2229  3074   2193 1598 2973   1637 1029 2317
       1816  1243 1060 1490    668   213  833    136    45   226   2127  1525  2730   1506  799 2219   1427  608 2224
       1825  1220 1140 1325    733   680  783    280    93   362   2413  2161  2754   1731 1243 2086
       1851  1356 1075 1785   1012   705 1253   1163   611  1945   2734  2029  3456   2303 1598 3151
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RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH AVG	PH MIN	PH MAX	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
927-1I	1815	5.17	5.00	5.30	14429	14185	14876	119	116	124	0.1	-2.3	3.5
	1816												
	1825	4.70	4.50	4.90	14282	14173	14391	137	124	151	0.3	-3.9	4.5
	1851												
927-1J	1815	5.20	5.10	5.40	10989	10302	11517	115	91	138	3.2	-2.0	6.3
	1816												
	1825	4.80	4.60	5.00	10820	10270	11389	137	109	166	6.9	5.4	8.4
	1851												
927-1K	1815	4.83	4.70	5.00	14753	14366	15247	131	108	154	4.8	2.1	6.8
	1816												
	1825	4.35	4.20	4.50	14657	14145	15393	144	118	194	6.6	3.9	9.7
	1851												
927-1L	1815	4.75	4.70	4.80	14802	14742	14863	124	123	126	3.7	2.0	5.4
	1816												
	1825	4.45	4.40	4.50	14867	14651	15083	139	137	141	3.3	3.3	3.3
	1851												
927-1M	1815	5.01	4.70	5.20	14354	12735	15575	109	100	127	12.0	7.4	18.1
	1816												
	1825	4.60	4.40	4.80	14226	12597	15419	120	105	136	12.0	3.4	18.6
	1851												
927-1N	1815	5.10	5.10	5.10	14686	14093	15279	107	100	114	7.9	6.2	9.6
	1816												
	1825	4.70	4.70	4.70	14018	14018	14018	119	119	119	8.9	8.9	8.9
	1851												
927-10	1815	4.64	4.50	5.00	16832	15552	17946	105	94	112	7.0	3.1	10.7
	1816												
	1825	4.34	4.20	4.60	16796	15499	17909	125	110	172	6.8	3.4	10.4
	1851												
927-1P	1815	5.05	4.90	5.30	15907	13734	18081	128	113	180	8.2	2.3	17.2
	1816												
	1825	4.71	4.60	4.90	16012	13615	18032	136	116	182	10.2	3.1	17.8
	1851												
951-1A	1815	5.56	5.40	5.80	5660	4640	7097	95	82	112	5.6	-6.2	15.6
	1816	8.00	7.30	8.40	3956	3143	4657	92	84	103	6.7	-0.4	16.2
	1825	5.09	4.90	5.30	4865	3798	6093	105	68	127	-2.9	-12.6	14.3
	1851	4.51	4.30	4.80	6664	5958	7758	112	70	138	-0.6	-11.1	12.5
952-1A	1815	5.49	5.30	6.00	8966	8090	11172	97	86	109	11.1	0.1	19.6
	1816	7.81	7.20	8.10	7300	4445	8895	94	84	109	11.2	0.7	18.9
	1825	5.64	5.40	5.80	6591	6089	6964	100	93	112	17.5	14.9	19.8
	1851	4.37	4.00	4.70	8858	7694	10909	103	84	138	6.1	-2.4	14.0

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
827-1A	1815	5.41	1.00	12.10	1.15	0.10	12.00	22.28	5.90	28.10	23.80	20.30	31.60	4.01	2.50	5.40	12.1	7.6	13.8
	1816	8.83	1.70	16.70	5.63	3.30	19.20	17.62	5.18	24.35	28.03	23.60	33.30	2.94	1.60	4.90	10.6	6.8	12.5
828-1A	1815	12.03	11.70	12.50	0.30	0.20	0.40	18.06	17.45	18.53	28.43	27.70	28.90	3.57	3.50	3.70	12.1	11.6	12.4
	1816	16.33	15.00	17.30	4.10	3.60	5.00	12.54	11.75	13.20	33.03	32.80	33.20	2.33	2.10	2.50	10.8	10.6	11.2
828-1B	1815	5.87	4.00	10.20	0.30	0.20	0.50	19.63	16.98	22.03	22.50	19.80	26.90	4.57	3.70	5.50	12.0	11.1	13.5
	1816	11.25	9.40	13.10	2.32	0.31	5.10	15.86	11.60	18.13	26.98	25.40	31.10	3.18	2.40	3.90	10.1	8.6	11.5
829-1A	1815	5.57	4.60	6.80	2.41	0.40	5.00	21.24	17.35	28.15	24.57	21.10	28.70	3.88	2.70	6.40	12.3	10.9	15.0
	1816	9.37	7.30	13.10	6.98	2.50	9.80	16.62	14.10	18.45	29.80	28.30	31.40	2.59	1.80	3.30	10.5	8.8	13.9
830-1A	1815	9.07	4.80	11.90	1.08	0.20	3.50	21.38	14.43	25.63	28.49	24.70	32.50	3.08	2.20	4.30	11.8	10.4	14.3
	1816	16.26	10.10	23.10	7.87	5.10	10.80	12.84	7.80	20.63	36.47	30.10	38.90	1.62	1.30	2.60	10.0	8.2	13.4
901-1A	1815	0.34	0.10	0.80	0.29	0.10	0.90	22.32	13.00	26.63	16.12	9.70	18.50	7.46	6.40	9.80	15.5	14.6	17.8
	1816	7.46	4.80	10.80	22.16	17.00	26.80	10.54	7.51	12.98	35.84	34.40	37.10	0.79	0.60	1.00	5.9	4.5	8.0
902-1A	1815	0.75	0.10	2.50	0.30	0.10	0.70	23.75	17.83	29.88	18.10	13.80	22.60	6.40	3.70	10.40	15.3	10.7	17.8
	1816	11.14	0.40	20.30	15.63	3.10	25.70	12.45	2.88	25.65	36.95	30.30	42.50	0.48	0.20	0.80	4.6	1.6	6.7
902-1B	1815	0.20	0.10	0.40	0.28	0.10	0.50	27.10	25.15	27.98	19.93	19.20	20.80	5.55	4.70	6.40	14.9	13.3	16.4
	1816	7.70	5.70	10.20	21.88	18.80	23.90	10.53	5.05	14.30	37.97	36.40	39.10	0.43	0.40	0.50	4.8	4.5	4.9
903-1A	1815	3.94	1.90	6.00	0.28	0.10	0.90	19.68	16.13	21.68	19.68	17.40	22.10	6.53	5.10	7.60	15.0	13.7	16.0
	1816																		
904-1A	1815	3.71	2.30	6.80	0.36	0.10	1.00	21.23	18.75	23.88	20.26	18.50	22.10	4.96	4.40	5.80	12.3	11.0	13.9
	1816																		

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
827-1A	1815	94.1	28.9	99.5	1.46	1.06	2.11	1.1	-6.7	7.3
	1816	71.2	23.8	85.3	1.72	1.09	2.72	-1.8	-8.2	6.2
828-1A	1815	98.0	97.3	98.6	2.19	2.14	2.28	0.6	-2.5	3.1
	1816	71.1	65.3	74.6	2.69	2.52	2.82	-0.5	-2.9	4.2
828-1B	1815	98.1	96.4	98.8	1.55	1.37	2.05	4.5	2.2	7.1
	1816	84.8	65.9	98.[illegible]	2.10	1.82	2.33	-2.1	-7.8	7.5
829-1A	1815	87.5	73.5	97.6	1.42	1.28	1.55	1.8	-5.2	7.9
	1816	66.1	55.1	83.5	1.69	1.47	2.26	0.3	-6.8	8.3
830-1A	1815	93.8	76.7	98.6	1.75	1.33	2.22	3.5	-1.6	7.2
	1816	56.3	41.6	76.4	2.34	1.71	3.36	-0.4	-7.7	7.9
901-1A	1815	98.3	95.4	99.5	1.03	1.01	1.06	-1.3	-7.4	6.4
	1816	27.8	18.3	37.9	1.36	1.21	1.62	-1.2	-8.3	5.5
902-1A	1815	98.4	96.4	99.6	1.06	1.01	1.18	1.4	-7.9	8.2
	1816	40.1	8.2	78.7	1.72	1.02	3.03	1.0	-4.6	5.8
902-1B	1815	98.7	97.7	99.6	1.01	1.01	1.03	2.3	-0.6	6.0
	1816	27.5	15.6	37.8	1.38	1.26	1.57	4.2	-1.9	7.2
903-1A	1815	98.2	94.1	99.4	1.36	1.17	1.57	3.3	-5.1	8.1
	1816									
904-1A	1815	97.9	93.8	99.5	1.32	1.17	1.65	1.8	-3.8	5.3
	1816									

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
905-1A	1815	1.33	0.20	2.00	0.26	0.10	0.40	24.06	15.53	28.75	18.85	13.60	22.40	6.03	4.70	8.60	14.6	13.7	16.4
	1816	8.93	1.90	13.80	9.87	0.50	19.30	18.93	10.10	28.40	33.46	24.40	39.10	0.41	0.30	0.60	3.2	2.3	4.3
906-1A	1815	1.66	0.40	3.70	0.28	0.10	0.90	23.59	20.15	26.15	19.78	17.40	23.30	5.82	5.00	7.20	14.9	13.6	16.0
	1816	9.40	6.30	11.40	20.67	16.90	24.50	9.93	7.70	12.73	37.98	33.70	40.00	0.60	0.50	0.70	6.8	5.7	8.2
907-1A	1815	1.50	0.10	4.50	0.26	0.10	1.70	23.18	9.98	30.73	18.69	9.70	24.40	6.18	4.10	10.30	14.9	11.9	18.7
	1816	13.18	8.10	21.10	18.32	8.50	27.50	9.13	1.95	20.85	39.61	35.30	42.90	0.54	0.30	0.80	6.1	3.8	9.1
907-1B	1815	1.57	0.20	12.90	0.39	0.10	6.70	25.19	7.55	32.68	20.29	5.70	39.30	5.58	3.20	12.20	14.8	11.4	18.5
	1816	13.50	8.80	28.00	18.65	1.80	26.50	9.47	2.15	17.80	40.32	37.00	45.20	0.45	0.20	0.80	6.0	4.4	8.2
908-1A	1815	2.99	0.40	8.90	0.52	0.20	1.50	22.97	11.03	26.98	20.80	16.30	24.20	5.53	4.20	7.30	14.7	12.4	17.4
	1816	16.34	11.30	26.20	12.99	6.90	20.20	10.43	5.50	14.05	39.82	36.60	43.40	0.61	0.50	0.70	6.8	5.2	8.9
909-1A	1805	1.64	0.10	5.10	5.98	0.20	19.80	21.24	6.28	33.33	22.92	5.50	29.20	5.14	1.70	13.00	14.6	5.3	21.3
	1816	2.24	0.10	15.10	17.13	10.00	23.00	11.70	2.95	18.90	26.62	22.70	34.40	3.65	1.10	5.30	11.6	4.4	16.2
910-1A	1805	0.89	0.30	2.00	8.09	0.20	22.40	20.59	9.40	28.55	23.42	21.00	29.40	5.76	4.10	7.00	18.0	15.6	20.4
	1816	1.31	0.20	3.50	20.27	16.40	25.50	9.78	6.03	14.80	26.51	25.00	30.29	4.86	3.90	5.40	15.4	14.1	17.0
911-1A	1805	2.96	1.40	5.20	3.14	0.10	13.90	25.71	15.63	32.00	24.96	22.50	28.50	5.86	3.30	8.30	21.8	10.8	30.1
	1816	3.86	2.20	10.10	8.82	0.30	15.00	18.24	14.30	22.20	26.02	23.50	28.30	4.48	4.00	5.20	14.8	13.8	16.1
912-1A	1805	2.32	0.90	5.30	12.18	0.40	18.10	15.36	12.48	20.95	25.05	18.50	29.30	5.53	4.20	9.10	16.3	15.0	18.3
	1816	1.73	0.80	3.60	17.28	13.80	19.20	12.19	10.90	14.75	26.62	26.00	27.30	4.58	4.20	5.00	14.6	13.5	16.0
913-1A	1805	1.00	0.70	1.20	12.40	1.20	24.60	19.00	11.25	28.30	24.80	21.70	30.10	5.60	4.00	6.90	17.8	15.7	19.3
	1816	0.87	0.30	1.30	21.87	19.30	25.90	10.90	7.63	13.48	27.97	26.80	29.60	3.70	3.20	4.10	13.7	13.3	14.2

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
905-1A	1815	98.6	97.6	99.5	1.10	1.01	1.23	0.1	-1.0	5.0
	1816	62.6	29.6	97.7	1.53	1.12	1.79	0.8	-6.6	7.8
906-1A	1815	98.6	95.5	99.5	1.13	1.03	1.27	4.5	0.0	6.9
	1816	27.8	20.5	36.8	1.49	1.30	1.64	2.5	-3.2	5.5
907-1A	1815	98.6	90.0	99.6	1.13	1.01	1.74	2.3	-7.5	7.9
	1816	28.8	7.2	61.1	1.77	1.37	2.59	0.9	-8.1	7.8
907-1B	1815	98.1	71.8	99.6	1.11	1.01	2.13	1.2	-8.2	8.2
	1816	29.7	7.6	85.9	1.78	1.42	3.96	0.4	-8.1	7.7
908-1A	1815	97.3	93.1	99.0	1.29	1.03	2.16	2.2	-1.5	8.0
	1816	40.1	23.7	52.4	2.27	1.62	4.29	0.8	-5.8	7.5
909-1A	1805	75.4	27.6	99.2	1.11	1.01	1.32	3.2	-4.3	8.2
	1816	35.1	13.6	60.2	1.14	1.01	2.27	2.1	-4.9	7.6
910-1A	1805	68.1	25.1	99.1	1.05	1.02	1.11	3.4	-1.2	8.3
	1816	27.9	15.9	41.9	1.07	1.01	1.19	1.0	-5.0	5.5
911-1A	1805	87.2	47.4	99.6	1.18	1.08	1.32	1.7	-2.7	6.8
	1816	63.5	44.4	98.2	1.25	1.12	1.86	2.3	-4.9	7.5
912-1A	1805	54.8	35.6	97.0	1.18	1.05	1.58	2.5	-0.9	5.6
	1816	36.0	32.2	46.1	1.10	1.04	1.20	3.0	1.1	7.7
913-1A	1805	59.0	26.8	95.0	1.05	1.04	1.06	-2.5	-4.5	-0.3
	1816	28.7	19.1	35.8	1.04	1.01	1.06	0.3	-1.7	2.8

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
914-1A	1815																		
	1816	11.98	5.90	17.90	0.35	0.10	1.70	16.59	13.78	19.58	27.52	20.60	33.30	5.06	3.50	6.60	15.8	13.0	18.4
914-1B	1815																		
	1816	19.00	19.00	19.00	0.50	0.50	0.50	14.18	14.18	14.18	35.50	35.50	35.50	2.20	2.20	2.20	10.3	10.3	10.3
914-1C	1815																		
	1816	1.02	0.50	1.40	14.00	12.10	16.60	8.34	6.33	11.28	19.87	18.10	21.40	6.85	6.10	7.50	14.9	13.9	15.7
915-1A	1815																		
	1816	2.97	0.90	16.40	17.29	5.40	21.70	8.22	4.58	11.20	24.44	22.60	30.70	5.32	1.10	6.40	13.7	3.3	16.0
915-1B	1805	1.63	1.10	2.30	6.53	5.90	7.50	23.34	22.03	24.03	24.07	23.60	24.40	5.27	5.00	5.80	16.8	16.2	17.5
	1816	2.00	1.30	2.40	20.50	20.20	21.00	8.66	7.65	9.85	26.80	26.20	27.50	5.20	5.00	5.50	15.7	15.2	16.0
915-1C	1815	1.50	1.50	1.50	7.40	7.40	7.40	22.45	22.45	22.45	23.30	23.30	23.30	5.30	5.30	5.30	16.3	16.3	16.3
	1816	5.53	1.10	14.60	7.61	0.20	16.80	15.62	11.40	18.58	24.08	21.00	28.50	5.81	4.90	6.30	15.2	13.5	16.7
916-1A	1815																		
	1816	4.41	0.40	10.30	0.13	0.00	0.40	23.37	19.30	26.88	21.81	17.40	26.40	5.22	2.00	6.90	13.6	4.8	16.2
916-1B	1815																		
	1816	2.58	0.70	4.50	0.07	0.00	0.10	27.00	20.08	30.20	22.22	18.80	24.50	5.19	4.50	6.60	15.3	14.2	16.4
916-1C	1815																		
	1816	1.98	0.70	5.20	0.08	0.00	0.20	27.40	24.58	29.38	21.06	18.50	24.20	5.27	4.80	5.80	15.1	13.5	17.5
916-1D	1815																		
	1816	5.37	1.10	8.70	0.04	0.00	0.10	25.22	19.48	30.00	23.66	19.80	27.80	5.10	3.50	6.50	15.0	13.9	17.1

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
914-1A	1815									
	1816	97.3	86.9	99.4	2.33	1.60	3.17	1.2	-2.1	7.5
914-1B	1815									
	1816	95.8	95.8	95.8	3.34	3.34	3.34	2.6	2.6	2.6
914-1C	1815									
	1816	32.2	24.0	42.7	1.07	1.04	1.10	2.3	-3.0	7.6
915-1A	1815									
	1816	28.6	14.4	51.1	1.27	1.05	3.16	-1.1	-6.0	3.6
915-1B	1805	74.1	70.1	76.5	1.09	1.06	1.13	-0.3	-2.2	2.5
	1816	25.3	22.6	28.1	1.11	1.07	1.13	0.8	-0.4	3.0
915-1C	1815	70.8	70.8	70.8	1.09	1.09	1.09	-3.5	-3.5	-3.5
	1816	67.1	35.2	98.5	1.53	1.06	2.75	-2.4	-8.5	3.5
916-1A	1815									
	1816	99.3	97.5	100.0	1.36	1.03	1.91	-1.3	-7.4	7.7
916-1B	1815									
	1816	99.7	99.4	100.0	1.18	1.05	1.41	-0.3	-5.8	4.3
916-1C	1815									
	1816	99.7	99.1	100.0	1.13	1.05	1.36	-3.4	-8.1	1.7
916-1D	1815									
	1816	99.8	99.4	100.0	1.40	1.07	1.81	-3.8	-8.5	1.2

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
916-1E	1815 1816	2.97	0.70	7.70	0.09	0.00	0.30	26.25	22.38	30.80	21.68	19.90	24.90	5.33	4.60	6.20	14.9	13.0	16.3
916-1F	1815 1816	11.68	3.50	16.80	0.10	0.00	0.20	23.56	19.88	28.78	30.80	22.80	35.00	3.64	2.00	5.10	15.7	14.3	16.4
916-1G	1815 1816	8.87	8.40	9.60	0.07	0.00	0.10	24.47	21.40	26.28	28.39	28.09	28.70	3.93	3.60	4.30	15.6	14.1	17.1
916-1H	1815 1816	3.86	0.60	14.40	10.66	0.10	15.70	18.95	16.28	25.58	27.00	24.60	32.90	4.38	3.00	5.20	15.1	13.6	16.7
917-1A	1815 1816	1.17	0.10	4.40	0.05	0.00	0.40	30.09	18.10	34.90	23.04	12.90	26.40	4.75	3.10	10.40	15.3	13.1	17.6
926-1A	1815 1816	0.68	0.10	5.40	12.87	7.90	20.40	16.29	7.15	20.83	23.55	20.89	26.20	5.59	4.40	6.40	15.2	12.4	16.9
926-1B	1815 1816	0.65	0.40	1.30	12.61	9.60	16.20	15.17	12.85	18.50	22.99	20.80	24.90	5.60	4.00	6.60	14.8	12.3	16.7
926-1C	1815 1816	0.90	0.30	2.30	14.07	7.30	20.10	16.11	10.18	23.78	24.38	22.40	26.40	5.41	3.70	6.00	15.2	14.1	16.3
926-1D	1815 1816	4.28	2.60	5.60	20.62	18.60	23.50	5.90	3.33	8.55	28.62	27.30	29.40	5.08	4.60	5.60	15.5	14.5	17.0
926-1E	1815 1816	0.97	0.60	2.20	16.93	12.60	21.10	9.61	4.60	14.35	23.59	21.70	27.10	6.19	5.00	6.80	15.3	14.0	17.0

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
916-1E	1815 1816	99.5	98.6	100.0	1.22	1.05	1.62	-2.6	-8.0	2.9
916-1F	1815 1816	99.5	99.0	100.0	1.95	1.22	2.53	-2.5	-8.4	3.5
916-1G	1815 1816	99.6	99.4	100.0	1.66	1.58	1.81	-0.5	-6.1	5.6
916-1H	1815 1816	61.3	45.3	99.5	1.28	1.03	2.27	-2.0	-8.2	3.2
917-1A	1815 1816	99.8	98.2	100.0	1.07	1.01	1.30	1.9	-6.8	7.9
926-1A	1815 1816	50.3	25.5	66.8	1.04	1.01	1.36	0.2	-5.6	6.7
926-1B	1815 1816	49.2	38.8	60.7	1.04	1.02	1.08	2.1	-5.4	8.1
926-1C	1815 1816	48.1	29.2	72.3	1.05	1.02	1.14	-1.6	-7.9	3.3
926-1D	1815 1816	18.6	10.2	26.9	1.25	1.14	1.35	3.4	-0.7	7.2
926-1E	1815 1816	31.3	15.6	47.7	1.06	1.03	1.12	3.4	0.8	7.1

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
926-1G	1815 1816	0.67	0.20	1.70	13.98	11.20	20.20	15.17	11.28	19.33	24.31	22.10	27.30	5.40	4.60	6.50	15.0	13.3	18.3
926-1H	1815 1816	1.54	1.00	2.40	18.70	14.80	23.20	9.84	6.30	12.95	25.76	24.60	28.90	5.54	4.50	6.30	15.0	13.9	16.1
927-1A	1815 1816	1.43	0.80	2.00	13.24	9.80	14.70	9.46	7.30	12.08	20.44	16.70	23.50	6.93	6.20	8.50	14.6	13.7	15.6
927-1B	1815 1816	0.90	0.80	1.00	10.70	10.30	11.20	6.89	5.65	7.73	16.13	15.10	17.00	8.50	8.20	8.70	14.7	14.3	15.1
927-1C	1815 1816	1.17	0.80	1.50	12.97	9.30	16.50	8.05	6.35	9.68	18.83	15.80	22.30	7.40	6.90	8.10	14.3	13.8	15.6
927-1D	1815 1816	2.47	1.70	3.30	12.10	11.10	12.70	7.01	6.63	7.28	19.00	18.50	19.70	8.60	8.50	8.70	16.3	15.6	16.9
927-1E	1815 1816	2.86	0.70	3.90	14.96	11.00	17.90	7.72	4.80	10.30	22.03	18.20	24.00	6.77	6.10	7.80	15.2	13.8	15.8
927-1F	1815 1816	2.53	1.90	3.20	19.27	17.00	21.30	6.62	5.88	7.83	24.73	22.40	26.90	5.47	4.70	6.80	15.0	14.6	15.3
927-1G	1815 1816	2.50	2.30	2.70	16.05	13.90	18.20	7.84	6.55	9.13	23.40	22.60	24.20	6.20	5.90	6.50	14.5	14.3	14.6
927-1H	1815 1816	2.20	2.20	2.20	18.90	18.90	18.90	5.88	5.88	5.88	24.60	24.60	24.60	6.00	6.00	6.00	15.0	15.0	15.0

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
926-1G	1815 1816	46.7	33.9	57.4	1.04	1.01	1.10	2.4	-4.3	8.0
926-1H	1815 1816	29.7	21.0	37.5	1.08	1.05	1.15	2.1	-5.2	8.2
927-1A	1815 1816	36.4	30.9	45.8	1.10	1.07	1.12	2.0	-2.6	7.0
927-1B	1815 1816	33.9	29.9	37.5	1.08	1.07	1.09	4.9	4.7	5.2
927-1C	1815 1816	33.7	25.8	45.4	1.09	1.07	1.10	1.8	-1.0	4.6
927-1D	1815 1816	31.7	29.5	33.9	1.21	1.14	1.29	1.8	-1.6	4.0
927-1E	1815 1816	29.4	19.4	41.7	1.20	1.05	1.27	-0.4	-6.3	4.3
927-1F	1815 1816	21.6	18.1	24.3	1.15	1.11	1.18		-0.3	0.2
927-1G	1815 1816	28.4	22.4	34.4	1.17	1.16	1.17	3.0	1.0	4.9
927-1H	1815 1816	19.9	19.9	19.9	1.14	1.14	1.14	4.6	4.6	4.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2			SO2			SO3			CAO			ACID INSOLUBLES			SOLIDS IN SLURRY, WT %		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
927-1I	1815	1.27	0.90	1.60	17.77	15.00	21.30	9.13	7.75	11.55	24.23	23.30	26.00	6.20	5.70	6.50	15.6	15.0	16.2
	1816																		
927-1J	1815	1.27	0.80	2.00	11.57	10.50	12.40	6.11	5.05	6.98	16.73	16.30	17.20	8.30	8.20	8.50	14.8	14.3	15.4
	1816																		
927-1K	1815	0.93	0.80	1.20	16.60	13.80	18.80	6.90	4.70	9.15	21.18	19.40	22.60	6.25	4.20	7.60	14.7	14.3	15.2
	1816																		
927-1L	1815	1.40	1.00	1.80	14.10	12.40	15.80	7.53	6.45	8.60	20.45	19.70	21.20	6.75	6.50	7.00	13.6	13.0	14.1
	1816																		
927-1M	1815	13.45	7.00	21.70	0.13	0.00	0.30	18.29	13.05	22.68	30.39	24.60	36.80	4.14	2.80	5.30	15.2	12.3	16.4
	1816																		
927-1N	1815	15.40	14.90	15.90	0.10	0.10	0.10	15.23	13.98	16.48	30.30	30.30	30.30	4.65	4.30	5.00	16.1	15.9	16.3
	1816																		
927-1O	1815	4.30	1.10	13.10	0.39	0.00	0.40	19.20	16.10	20.30	19.00	14.50	27.30	6.95	5.00	8.80	15.2	13.6	16.3
	1816																		
927-1P	1815	12.84	6.10	29.20	10.49	0.30	17.00	4.63	3.48	6.73	28.71	24.40	40.70	5.53	2.50	7.40	14.9	12.1	17.2
	1816																		
951-1A	1815	0.41	0.10	1.40	1.07	0.21	2.20	22.45	17.95	28.78	17.23	14.20	19.91	7.19	5.70	8.80	15.7	13.0	18.2
	1816	2.99	1.70	5.70	27.75	22.90	31.80	7.89	3.91	11.96	33.06	27.30	37.10	0.82	0.40	1.70	6.3	2.5	15.3
952-1A	1815	0.29	0.10	1.00	0.69	0.21	2.80	25.74	22.83	28.70	19.19	17.00	22.80	5.87	4.20	7.90	15.8	11.8	22.3
	1816	5.17	2.00	9.30	24.30	12.80	31.50	9.64	2.33	13.78	34.92	30.30	37.30	0.57	0.20	1.50	4.5	2.1	6.8

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION			STOICHIOMETRIC RATIO			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
927-1I	1815	29.4	23.3	38.1	1.08	1.05	1.10	2.8	2.1	4.1
	1816									
927-1J	1815	29.7	25.5	34.7	1.11	1.07	1.18	4.3	0.9	7.4
	1816									
927-1K	1815	25.1	17.6	34.7	1.06	1.05	1.08	2.9	-0.6	6.3
	1816									
927-1L	1815	30.2	24.6	35.7	1.11	1.07	1.14	5.1	2.7	7.4
	1816									
927-1M	1815	99.0	97.6	100.0	2.43	1.56	3.97	0.6	-5.7	6.7
	1816									
927-1N	1815	99.2	99.1	99.2	2.83	2.74	2.92	-0.3	-5.2	4.7
	1816									
927-1O	1815	99.4	97.4	100.0	1.42	1.11	2.48	0.2	-3.1	6.3
	1816									
927-1P	1815	31.8	18.0	93.8	3.11	1.46	9.85	-0.2	-6.7	5.9
	1816									
951-1A	1815	94.4	86.7	99.0	1.03	1.01	1.10	0.4	-7.6	6.5
	1816	18.4	9.3	25.5	1.13	1.07	1.24	-1.9	-7.8	6.6
952-1A	1815	97.2	89.0	99.1	1.02	1.01	1.07	1.3	-7.7	8.0
	1816	24.3	5.6	46.0	1.24	1.08	1.57	0.8	-4.9	7.1

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
625-2A	2816	1497	838	2380	360	136	560	153	23	588	1806	863	2724	2165	1154	3728			
	2825	1698	1130	2475	371	51	578	850	204	1447	1970	806	2737	2140	1154	3550			
901-2A	2816	1685	1565	2275	894	663	1050	861	36	3483	2669	2185	3240	2385	1642	2840	1535	944	2116
	2825	1988	1550	2385	906	675	1065	1277	100	2646	2687	1917	3259	2433	1686	3260			
901-2H	2816	1655	1500	1950	947	685	1213	339	9	1665	2634	2269	3012	2303	1642	2796	1568	1373	1888
	2825	1775	1565	2060	933	685	1230	699	172	1529	2750	2368	3037	2303	1642	2796			
901-2I	2816	1801	1685	1959	993	818	1085	281	54	878	2756	2368	3197	2586	2308	2840	1565	1173	1916
	2825	1914	1615	2215	973	793	1080	709	217	1529	3042	2632	4311	2582	2219	2849			
901-2J	2816	1822	1380	2150	968	605	1120	526	181	1312	2666	2227	3215	2634	1464	3417	1515	1201	2031
	2825	1906	1345	2295	947	590	1140	892	235	1877	2676	2156	3146	2599	1553	3461			
902-2A	2816	1982	1720	2220	985	883	1113	598	127	1375	2738	2362	3028	2799	2485	3284	1568	1401	1687
	2825	2168	1960	2365	991	905	1145	1066	534	1538	2964	2557	3389	2832	2485	3284			
902-2B	2816	2007	1675	2250	1076	968	1190	788	54	1764	2796	2384	3000	2928	2663	3328	1698	1401	2088
	2825	2124	1750	2450	1079	1008	1185	1295	271	2443	3052	2554	3319	2911	2707	3328			
903-2A	2816	1368	1090	1795	721	325	1083	108	45	181	2386	2222	2514	1775	799	2929	1098	629	1516
	2825	1509	1240	1980	713	320	1080	734	498	814	2627	2469	2868	1739	799	2884			
903-2B	2816	1599	1480	1665	898	678	1159	64	9	389	2357	1949	2847	2495	2263	2862	1534	1087	1945
	2825	1792	1550	2035	877	670	1115	446	18	760	2914	2406	3533	2477	2219	2840			
904-2A	2816	899	720	1050	218	141	287	308	9	941	2242	2064	2404	332	222	444			
	2825	1060	850	1275	225	151	301	878	289	1565	2302	1933	2811	319	222	399			
904-2B	2816	1043	805	1250	348	244	430	453	18	1628	2292	1970	2654	883	399	1553			
	2825	1208	825	1460	340	258	418	939	208	2239	2376	2148	2760	870	399	1509			
904-2C	2816	1188	980	1350	497	348	590	327	9	1031	2437	2046	2753	1452	910	1642			
	2825	1379	1080	1650	493	360	600	814	72	1565	2673	2204	3457	1435	910	1686			
904-2D	2816	1637	1099	1935	565	485	663	1102	90	2013	2807	1894	3921	1939	1420	2396			
	2825	1795	1150	2055	556	495	658	1696	100	2805	2671	2313	3425	1939	1420	2396			
904-2E	2816	1548	1180	1860	632	525	695	332	9	1167	2307	1995	2668	2601	2219	2840			
	2825	1679	1349	2040	622	518	670	609	45	1601	2617	2377	3151	2603	2263	2840			
904-2F	2816	1418	1300	1540	730	645	803	21	5	54	2091	1966	2173	2769	2352	3035			
	2825	1600	1455	1690	731	655	805	224	18	507	2492	2286	2688	2758	2352	2973			
904-2G	2816	1231	1140	1415	466	430	505	119	9	769	1989	1790	2420	1942	1669	2396			
	2825	1320	1180	1535	483	398	525	283	9	1058	2317	1749	2649	1924	1633	2352			
904-2H	2816	1380	1205	1680	432	333	518	338	14	950	2005	1613	2346	1863	1677	2024			
	2825	1407	1270	1790	420	355	495	544	59	1312	2112	1772	2452	1846	1669	1988			
904-2I	2816	1288	1150	1455	418	388	445	191	22	850	2040	1686	3069	1801	1516	2130			
	2825	1425	1195	1715	423	390	455	459	118	1357	2121	1754	2952	1794	1555	2130			
904-2J	2816	2430	2660	2630	677	635	730	581	27	837	2125	2016	2369	4153	3875	4438			
	2825	2606	2350	2790	664	613	715	1047	244	1447	2315	1808	2851	4123	3905	4378			
904-2K	2816	2211	2160	2300	707	618	743	37	5	127	1669	1648	1680	4437	4260	4556			
	2825	2375	2330	2490	711	625	748	314	136	398	2173	2094	2295	4439	4378	4526			
904-2L	2816	2505	2440	2570	683	613	753	52	18	86	2295	1926	2664	4482	4438	4526			
	2825	2936	2580	3220	673	595	745	489	100	811	2404	2048	2938	4684	4378	5177			

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH AVG	PH MIN	PH MAX	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
625-2A	2816	7.98	5.70	9.00	6078	3653	8696	108	52	170	4.4	-9.6	15.3
	2825	5.15	4.50	6.10	7127	4941	9740	122	51	161	-3.8	-13.4	15.2
901-2A	2816	5.19	4.50	5.70	6747	5546	7837	129	99	166	13.3	3.8	18.6
	2825	4.86	4.40	5.40	6860	5619	7799	132	93	173	14.3	6.1	20.0
901-2H	2816	5.42	5.00	6.50	6632	5664	7264	116	102	131	14.5	8.1	17.8
	2825	5.03	4.60	6.50	6632	5638	7490	126	111	139	15.1	6.9	19.7
901-2I	2816	5.33	5.10	5.50	7125	6233	7946	124	106	140	14.4	8.8	17.4
	2825	4.97	4.60	5.20	7127	6303	8121	140	121	175	12.0	-1.4	19.3
901-2J	2816	5.27	5.10	5.90	7044	5024	8468	122	102	138	12.9	9.3	17.3
	2825	4.98	4.80	5.70	6945	5048	8484	127	105	146	13.8	10.0	19.8
902-2A	2816	5.27	5.00	5.60	7456	6866	8218	131	109	144	13.7	5.0	17.9
	2825	4.92	4.70	5.10	7591	6976	8269	147	126	165	13.8	6.1	16.2
902-2B	2816	5.20	5.00	5.30	7810	7113	8714	129	101	141	13.5	7.1	17.0
	2825	4.90	4.70	5.02	7802	7283	8542	145	108	160	12.2	9.8	14.9
903-2A	2816	5.60	5.20	6.20	5100	2895	7513	109	98	117	12.1	5.0	16.9
	2825	5.00	4.30	5.40	5074	2926	7510	125	116	137	9.8	-0.8	16.9
903-2B	2816	5.46	5.30	5.70	6716	6109	7681	105	95	113	12.4	9.0	16.6
	2825	4.85	4.70	5.00	6788	6085	7768	137	118	160	10.5	3.6	16.1
904-2A	2816	5.49	5.40	5.60	1453	1251	1678	119	101	129	7.4	-3.1	17.3
	2825	5.14	4.90	5.30	1497	1294	1689	129	117	152	7.5	2.6	12.4
904-2B	2816	5.45	5.20	5.90	2295	1545	3260	115	94	136	7.1	-5.1	12.7
	2825	5.19	5.00	5.50	2342	1548	3200	127	104	142	6.6	-2.8	14.8
904-2C	2816	5.29	5.16	5.47	3240	2490	3570	116	101	150	9.3	2.3	15.7
	2825	4.99	4.80	5.10	3298	2631	3744	134	114	172	6.7	-6.1	18.0
904-2D	2816	5.18	5.00	5.93	4116	3176	4783	146	98	188	5.8	-1.3	15.8
	2825	4.98	4.80	5.47	4148	3237	4754	146	110	175	7.2	-3.1	11.9
904-2E	2816	5.25	5.00	5.40	4939	4380	5278	116	98	139	7.7	-6.5	16.4
	2825	4.96	4.82	5.20	5008	4501	5389	136	117	165	4.5	-6.4	12.5
904-2F	2816	5.41	5.29	5.67	5148	4498	5644	96	92	100	11.8	7.4	13.8
	2825	4.96	4.60	5.23	5276	4669	5669	120	111	127	10.1	5.9	12.6
904-2G	2816	5.54	5.30	5.80	3776	3510	4265	101	93	134	6.9	-0.4	14.7
	2825	4.95	4.70	5.20	3830	3538	4285	118	90	150	4.2	-1.4	10.6
904-2H	2816	5.39	5.10	5.70	3767	3453	4093	109	90	128	10.0	2.9	15.1
	2825	5.14	4.80	5.40	3727	3409	4028	116	100	140	6.5	0.1	12.1
904-2I	2816	5.32	5.09	5.42	3617	3369	4031	108	90	157	7.5	-4.2	16.7
	2825	5.06	4.80	5.20	3703	3411	4264	117	102	155	8.7	-4.3	17.8
904-2J	2816	5.13	5.00	5.30	7420	6716	7920	129	118	144	9.4	3.4	13.7
	2825	4.85	4.80	4.97	7462	6850	7882	144	115	175	8.4	3.3	13.9
904-2K	2816	5.33	5.20	5.50	7599	7446	7805	98	96	102	9.4	6.0	11.6
	2825	5.03	4.90	5.10	7700	7462	7868	129	122	143	6.1	3.7	8.6
904-2L	2816	5.13	5.00	5.25	7934	7830	8039	139	121	158	8.3	7.0	9.5
	2825	4.74	4.30	5.11	8481	7716	9217	155	132	185	10.9	7.5	14.4

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++			MG++			SO3=			SO4=			CL-			AD=		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
904-2M	2816	2820	2820	2820	603	603	603	669	669	669	1855	1855	1855	4497	4497	4497			
	2825	2900	2900	2900	588	588	588	724	724	724	2503	2503	2503	4497	4497	4497			
904-2N	2816	2028	1750	2290	500	460	573	618	262	1049	2023	1716	2347	3025	2810	3195			
	2825	2162	1980	2480	494	458	545	970	746	1429	2340	1771	2672	2990	2810	3195			
904-2O	2816	2506	2450	2550	650	573	693	518	54	1031	1798	1549	2192	4333	3089	5177			
	2825	2745	2700	2790	702	695	710	701	289	1113	1896	1719	2074	4992	4763	5221			
904-2P	2816	2553	1980	3130	575	493	625	559	27	1493	2492	1951	2821	4388	3432	5266			
	2825	2680	1960	3420	575	485	635	794	249	1855	2527	2103	3019	4418	3432	5325			
904-2Q	2816	1875	1390	2080	590	525	665	362	145	588	1878	1526	2083	3161	3035	3373			
	2825	1972	1410	2160	565	525	600	669	425	905	1928	1690	2296	3133	3018	3432			
904-2R	2816	1866	1790	1920	572	550	585	245	167	362	1962	1910	2065	3011	2947	3053			
	2825	1916	1620	1990	569	550	583	404	190	561	2042	1960	2087	3023	2929	3124			
904-2S	2816	2000	2000	2000	565	565	565	122	122	122	1822	1822	1822	3302	3302	3302			
	2825	2090	2090	2090	568	568	568	448	448	448	2240	2240	2240	3302	3302	3302			
904-2U	2816	1940	1940	1940	395	395	395	208	208	208	1713	1713	1713	4053	4053	4053			
	2825	2040	2040	2040	413	413	413	244	244	244	1670	1670	1670	4023	4023	4023			
905-2A	2816	2540	2330	2890	486	360	590	51	9	81	1794	1397	2004	4398	3668	4793			
	2825	2523	2350	2860	462	353	545	108	81	136	1793	1334	2152	4408	3639	4852			
905-2B	2816	2446	2160	2630	557	478	605	183	45	416	1820	1610	1997	4176	3461	4940			
	2825	2590	2180	2740	542	480	590	362	100	651	1919	1680	2088	4161	3461	4940			
905-2C	2816	2196	2080	2390	564	530	593	253	163	317	1862	1729	2089	3698	3461	3905			
	2825	2236	2130	2420	573	535	605	428	262	525	1912	1746	2176	3698	3506	3949			
905-2D	2816	2160	2050	2250	636	578	665	84	72	109	2116	1886	2517	3624	3328	3772			
	2825	2223	2080	2340	605	573	640	324	177	398	2261	2165	2415	3491	3373	3683			
905-2E	2816	2060	1980	2190	577	525	630	436	72	651	1955	1849	2073	3206	2840	3461			
	2825	2197	2140	2360	566	548	595	701	109	1086	2051	1924	2140	3195	2929	3284			
905-2F	2816																		
	2825																		
905-2G	2816																		
	2825																		
905-2H	2816	1740	1740	1740	590	590	590	163	163	163	1855	1855	1855	3106	3106	3106			
	2825	1610	1610	1610	605	605	605	109	109	109	2183	2183	2183	3106	3106	3106			
905-2I	2816	1486	1400	1590	654	628	705	144	90	253	2158	2127	2206	2721	2529	3062			
	2825	1573	1480	1650	650	615	703	286	109	597	2382	2203	2551	2742	2547	3018			
906-2A	2816	1515	910	1780	660	570	855	42	9	100	1856	1616	2138	2355	1686	2964	1303	944	2059
	2825	1747	1490	2030	655	560	850	470	235	642	2040	1725	2444	2372	1669	2964			
906-2B	2816	1497	1365	1625	660	620	693	64	27	154	1834	1698	1902	2636	2379	2805	836	744	944
	2825	1686	1555	1880	628	595	688	562	364	887	2141	1937	2446	2664	2368	2964			
906-2C	2816	1593	1460	1850	612	578	635	208	18	579	1927	1920	1939	2365	2166	2515	819	801	829
	2825	1641	1590	1720	629	615	655	552	489	624	2053	2025	2075	2246	2160	2379			
906-2D	2816	1566	1480	1730	639	583	700	31	18	45	1776	1625	1978	2822	2663	3071	758	658	858
	2825	1776	1630	1930	625	580	658	424	308	525	2026	1929	2133	2831	2663	3089			

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH AVG	PH MIN	PH MAX	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
904-2M	2816	5.10	5.10	5.10	8048	8048	8048	124	124	124	12.8	12.8	12.8
	2825	4.80	4.80	4.80	8094	8094	8094	166	166	166	6.9	6.9	6.9
904-2N	2816	5.25	5.18	5.30	5664	5166	5949	124	105	137	10.0	5.1	14.5
	2825	5.07	5.00	5.12	5687	5331	6051	145	117	174	7.2	4.7	10.7
904-2O	2816	5.16	5.00	5.47	7653	6144	8683	113	97	139	11.7	7.3	17.9
	2825	4.93	4.70	5.15	8578	8288	8868	120	110	131	7.5	4.3	10.7
904-2P	2816	4.96	4.90	5.08	7687	6139	8719	158	120	181	1.1	-10.4	7.6
	2825	4.74	4.50	4.91	7776	6065	8798	163	128	206	1.1	-6.8	8.6
904-2Q	2816	5.32	5.28	5.41	5800	5317	6090	106	95	123	11.4	1.6	15.8
	2825	5.06	4.99	5.15	5771	5175	6248	112	100	137	9.8	-3.5	15.9
904-2R	2816	5.43	5.40	5.50	5637	5596	5698	113	110	119	13.1	10.9	15.0
	2825	5.10	5.10	5.10	5666	5604	5789	119	115	122	11.7	9.5	14.6
904-2S	2816	5.50	5.50	5.50	6071	6071	6071	109	109	109	14.0	14.0	14.0
	2825	5.30	5.30	5.30	6104	6104	6104	134	134	134	8.6	8.6	8.6
904-2U	2816	5.20	5.20	5.20	6564	6564	6564	111	111	111	-11.8	-11.8	-11.8
	2825	5.10	5.10	5.10	6678	6678	6678	110	110	110	-4.8	-4.8	-4.8
905-2A	2816	5.63	5.30	6.00	7609	6504	8416	121	99	135	6.5	-4.6	12.1
	2825	5.20	4.90	5.50	7623	6488	8580	122	96	146	5.6	-4.9	13.5
905-2B	2816	5.33	5.10	5.70	7363	6281	8330	118	106	129	10.1	5.9	13.5
	2825	4.90	4.70	5.20	7359	6303	8384	125	112	136	8.8	5.9	10.8
905-2C	2816	5.37	5.30	5.40	6629	6265	7097	115	107	129	10.4	3.2	15.3
	2825	4.97	4.90	5.00	6636	6315	7140	118	111	134	9.8	4.1	14.2
905-2D	2816	5.37	5.30	5.50	6584	6216	6921	125	108	151	11.4	9.0	15.6
	2825	5.03	5.00	5.10	6491	6251	6788	136	129	150	11.2	8.5	12.9
905-2E	2816	5.30	5.10	5.40	5974	5485	6299	117	108	126	13.3	10.6	16.9
	2825	5.04	4.96	5.18	6049	5641	6365	126	120	131	13.6	9.1	19.3
905-2F	2816												
	2825												
905-2G	2816												
	2825												
905-2H	2816	5.50	5.50	5.50	5640	5640	5640	103	103	103	10.5	10.5	10.5
	2825	5.10	5.10	5.10	5556	5556	5556	115	115	115	3.2	3.2	3.2
905-2I	2816	5.57	5.50	5.70	5049	4743	5563	106	105	107	8.5	7.7	9.0
	2825	5.13	5.10	5.20	5107	4798	5560	119	113	126	5.7	3.1	7.2
906-2A	2816	5.73	5.40	6.00	6042	4777	7541	92	72	110	9.6	-13.5	15.0
	2825	5.15	4.80	5.50	6217	4862	7678	108	92	126	12.1	6.0	17.1
906-2B	2816	5.85	5.70	6.10	5829	5305	6173	91	87	95	8.2	0.5	14.5
	2825	5.18	5.00	5.60	5909	5412	6331	113	106	125	4.2	-7.5	12.3
906-2C	2816	6.03	6.00	6.10	5565	5301	5860	101	96	110	11.8	9.0	14.6
	2825	5.33	5.20	5.50	5467	5366	5636	108	106	110	12.8	11.3	14.9
906-2D	2816	5.73	5.50	5.90	6005	5601	6670	92	85	102	7.7	1.4	12.4
	2825	5.22	4.80	5.50	6133	5792	6725	110	105	119	7.6	-0.7	11.6

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++			MG++			SO3=			SO4=			CL-			AD=		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
907-2A	2816	1395	1395	1395	1890	1890	1890	515	515	515	4043	4043	4043	2526	2526	2526	2059	2059	2059
	2825																		
907-2B	2816																		
	2825																		
907-2C	2816																		
	2825																		
907-2D	2816																		
	2825																		
907-2E	2816																		
	2825																		
907-2F	2816																		
	2825																		
907-2G	2816																		
	2825																		
907-2J	2816	1175	1175	1175	620	620	620	751	751	751	2542	2542	2542	621	621	621	1745	1745	1745
	2825	1335	1240	1430	822	640	1005	1296	969	1623	2734	2721	2747	754	621	888			
907-2K	2816																		
	2825																		
907-2L	2816																		
	2825																		
907-2M	2816																		
	2825																		
926-2A	2816	1081	726	1358	210	139	303	304	158	701	1575	964	1993	1002	843	1331			
	2825	1107	720	1385	211	140	298	335	90	543	1614	1095	2031	1005	799	1376			
927-2A	2816	1517	912	2635	656	540	763	452	90	1176	2259	679	3136	2445	1065	4837	361	143	608
	2825	1551	940	2635	644	525	778	719	181	1764	2290	1363	3062	2379	1065	4881			
928-2A	2816	1939	1585	2490	754	650	823	302	90	543	1940	1380	2514	3223	2663	3861	1583	1187	2288
	2825	1974	1545	2495	751	643	845	453	113	950	2001	1244	2583	3250	2840	3861			
929-2A	2816	1983	1205	2755	764	680	833	254	136	407	2101	1293	2640	3566	2485	5059	887	615	2231
	2825	1975	1255	2730	757	693	843	364	271	588	2042	1175	2673	3591	2441	5059			
930-2A	2816	1974	1230	2870	819	635	935	200	90	407	1575	807	2369	4006	2663	5325	697	558	1001
	2825	1981	1215	2940	823	628	948	274	136	792	1527	753	2455	4004	2663	5325			
931-2A	2816	2103	1730	2765	873	653	970	1023	226	2103	2160	1794	2841	4030	3506	4615	840	572	1173
	2825	2210	1920	2825	878	815	945	1499	475	2533	2157	1750	2415	3987	3506	4615			
932-2A	2816	2857	1540	3830	754	523	1025	339	90	1402	1774	769	2589	5251	3196	7562	1618	944	2288
	2825	2892	1575	4000	748	513	1040	473	181	1651	1822	903	2985	5227	1473	7633			
933-2A	2816	2168	1385	3180	626	443	860	259	45	769	1846	1596	2225	3884	2441	6079			
	2625	2236	1435	3170	619	483	895	415	23	1267	1913	1358	2324	3909	2485	6124			
934-2A	2816	1939	1550	2160	458	72	775	2564	1054	3585	1790	1320	2854	1570	490	2386	1533	1459	1573
	2825	1968	1460	2195	500	83	800	2988	1990	3622	1766	1163	2868	1645	500	2361			
934-2B	2816	1765	1695	1860	868	750	925	1207	960	1635	2128	1903	2348	2236	2176	2325	1515	1430	1773
	2825	1901	1765	2005	889	810	965	2020	1077	2730	2282	2063	3347	2224	2130	2343			

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALY TICAL POINT	PH AVG	PH MIN	PH MAX	TOTAL IONS, PPM AVG	TOTAL IONS, PPM MIN	TOTAL IONS, PPM MAX	PERCENT SULFATE SATURATION AVG	PERCENT SULFATE SATURATION MIN	PERCENT SULFATE SATURATION MAX	PERCENT IONIC IMBALANCE AVG	PERCENT IONIC IMBALANCE MIN	PERCENT IONIC IMBALANCE MAX
907-2A	2816	4.97	4.97	4.97	7879	7879	7879	108	108	108	20.0	20.0	20.0
	2825												
907-2B	2816												
	2825												
907-2C	2816												
	2825												
907-2D	2816												
	2825												
907-2E	2816												
	2825												
907-2F	2816												
	2825												
907-2G	2816												
	2825												
907-2J	2816	5.18	5.18	5.18	4095	4095	4095	111	111	111	11.1	11.1	11.1
	2825	5.43	4.58	6.27	4533	4191	4876	114	99	129	17.0	15.2	18.7
907-2K	2816												
	2825												
907-2L	2816												
	2825												
907-2M	2816												
	2825												
926-2A	2816	5.64	5.40	5.90	4249	3365	5091	96	53	134	6.8	-10.1	15.2
	2825	5.23	5.00	5.50	4349	3468	4999	99	63	131	6.1	-9.5	15.1
927-2A	2816	5.29	4.90	5.90	7848	5855	10830	107	43	139	2.1	-15.7	11.9
	2825	4.97	4.70	5.60	7749	5820	10620	111	79	144	1.7	-12.2	13.2
928-2A	2816	5.40	5.10	5.80	9849	7522	11574	104	68	135	3.7	-8.1	16.7
	2825	4.95	4.50	5.60	8608	7252	10209	108	61	142	12.8	-0.8	19.8
929-2A	2816	5.51	5.30	5.60	9671	6868	11794	111	57	137	3.2	-7.5	12.1
	2825	5.15	5.00	5.50	9726	7930	12144	108	54	132	2.7	-10.6	9.2
930-2A	2816	5.62	5.30	5.80	9447	6724	12723	84	36	136	6.9	-6.7	12.4
	2825	5.19	4.90	5.40	9482	6704	12490	82	37	135	7.5	-2.6	14.8
931-2A	2816	4.95	4.50	5.40	11230	9806	13748	113	96	147	-5.1	-12.1	3.6
	2825	4.58	4.30	5.10	11772	10016	14099	115	94	140	-6.4	-10.8	[illegible]
932-2A	2816	5.31	4.90	5.70	12800	7476	16410	111	45	162	-1.0	-12.4	12.5
	2825	4.97	4.50	5.50	12986	7832	17019	115	53	189	-0.2	-10.2	17.2
933-2A	2816	5.43	5.20	5.70	8917	6638	12348	110	94	134	5.6	-4.1	14.8
	2825	5.11	4.70	5.50	9225	7316	12594	115	87	141	3.5	-11.5	15.0
934-2A	2816	4.52	4.27	4.77	4915	1691	6215	113	86	159	9.4	1.7	17.8
	2825	4.02	3.50	4.47	4968	1639	6202	111	84	164	10.6	0.9	16.5
934-2B	2816	4.93	4.54	5.17	6227	6080	6546	102	98	110	15.5	12.9	20.0
	2825	4.32	4.03	4.74	6191	5898	6470	112	101	168	15.9	8.4	18.6

RUN SUMMARY - LIQUID ANALYTICAL DATA

CONCENTRATIONS IN LIQUID, PPM

RUN NO.	ANALYTICAL POINT	CA++ AVG	CA++ MIN	CA++ MAX	MG++ AVG	MG++ MIN	MG++ MAX	SO3= AVG	SO3= MIN	SO3= MAX	SO4= AVG	SO4= MIN	SO4= MAX	CL- AVG	CL- MIN	CL- MAX	AD= AVG	AD= MIN	AD= MAX
934-2C	2816	1868	1610	2430	346	118	568	583	115	4051	2033	1279	3190	1671	781	2278	1531	1316	1630
	2825	1938	1630	2515	355	118	585	1042	230	4051	2240	1309	3791	1687	790	2248			
934-2D	2816																		
	2825	1752	1705	1800	1445	1435	1455	1616	1499	1733	3254	3201	3307	2399	2361	2438			
934-2E	2816	1759	1470	1950	983	825	1098	1328	1157	1499	2346	2050	2740	2271	2201	2343	1527	1459	1602
	2825	1924	1835	2075	1018	950	1078	2396	2150	2693	2411	2192	2876	2286	2237	2379			
934-2F	2816	1919	1790	2115	1146	1030	1298	2613	1616	3768	2263	2073	2475	2344	2130	2698	1534	1459	1602
	2825	2133	2005	2250	1158	1075	1325	3632	2997	4187	2367	2125	2590	2432	2095	2769			
934-2G	2816																		
	2825	1865	1845	1885	1535	1330	1770	2798	2787	2810	3046	2783	3310	2654	2219	3089			
934-2H	2816	1544	1480	1635	1760	1670	1885	1160	620	1592	3639	3291	4167	2538	2426	2627	2345	2145	2517
	2825	1706	1585	1830	1685	1440	1915	2319	1320	2646	3812	2979	4781	2514	2367	2722			
935-2A	2816	894	720	1020	332	130	410	411	187	1026	2168	1659	2717	547	302	680			
	2825	981	740	1300	325	150	395	818	303	1935	2160	1646	2487	546	302	639			
951-2A	2816	1794	1640	1940	733	568	845	151	68	271	2302	2156	2821	2681	1686	3106	1252	1087	1544
	2825	1785	1295	2085	837	570	1470	1008	68	1380	2675	2080	3810	2637	1686	3062			
951-2B	2816	1767	1560	1975	803	653	973	264	113	475	2387	2142	2749	2768	2485	3176	1224	1030	1430
	2825	1807	1205	2140	854	615	1575	1136	249	1832	2666	2141	3755	2737	2485	2973			
951-2C	2816	1765	1660	1950	911	798	1003	228	45	814	2360	1570	3030	2864	2529	3106	1268	1058	1430
	2825	1682	1595	1960	885	735	998	812	294	1583	2440	1873	2875	2836	2396	3195			
951-2D	2816	1643	1400	1845	915	743	1048	80	23	181	2427	2142	2879	3185	2840	3550	1252	1115	1373
	2825	1541	1410	1775	900	755	1050	206	68	362	2723	2587	2968	3134	2751	3550			
951-2E	2816	1640	995	1800	957	888	1063	103	18	384	2381	1858	2834	2927	2707	3195	1280	972	1573
	2825	1555	1430	1640	933	673	1050	520	23	995	2662	1599	3225	2877	2396	3151			
976-2A	2816	1211	1000	1580	385	323	455	193	68	430	1694	1330	2102	1813	1420	2485			
	2825	1476	1260	1845	398	323	453	869	498	1334	2306	1709	2698	1797	1420	2574			
976-2B	2816	1054	916	1175	438	384	523	226	90	384	1740	1374	2045	1499	1420	1642			
	2825	1369	1225	1645	439	385	493	1060	136	1425	2183	1454	3161	1468	1035	1686			
977-2A	2816	1013	862	1095	496	451	578	241	113	362	2150	1768	2582	1235	1136	1376	423	250	601
	2825	1304	1165	1500	506	450	634	1195	859	1425	2507	1878	3033	1238	1109	1420			
978-2A	2816	2700	2400	3180	694	653	805	133	45	249	1975	1759	2234	5082	4615	5769			
	2825	3030	2570	3580	692	615	825	1074	814	1470	2120	1212	2925	5081	4704	5858			
979-2A	2816	1975	1680	2170	700	670	740	179	45	294	1633	1391	1829	3625	3506	3905	618	515	829
	2825	2366	2110	2740	709	678	743	1409	1312	1515	2147	1652	2581	3603	3417	3905			
980-2A	2816	1622	1330	2150	709	593	808	122	23	271	1556	1152	2131	2892	2396	3772	1212	658	1602
	2825	1859	1605	2380	723	593	803	1036	362	1447	1853	1348	2405	2880	2308	3861			
981-2A	2816	1888	1555	2240	731	660	768	208	68	475	1957	1555	2359	3062	2663	3373	1236	1115	1430
	2825	2192	1615	2585	742	638	795	1304	588	1877	2383	1120	3688	3052	2574	3417			

RUN SUMMARY - LIQUID ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PH			TOTAL IONS, PPM			PERCENT SULFATE SATURATION			PERCENT IONIC IMBALANCE		
		AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
934-2C	2816	5.31	3.37	5.67	5351	3981	6470	131	78	193	6.5	-14.6	18.8
	2825	4.78	4.28	5.19	5361	3984	6292	143	99	227	5.7	-17.1	19.4
934-2D	2816												
	2825	4.69	4.54	4.83	6968	6900	7036	120	120	121	20.0	19.9	20.0
934-2E	2816	4.98	4.82	5.08	6364	6118	6612	106	87	125	15.4	10.9	19.6
	2825	4.23	4.09	4.33	6364	6162	6730	113	101	135	16.8	11.1	20.0
934-2F	2816	4.64	4.58	4.68	6522	6043	7171	101	92	121	18.2	15.9	19.8
	2825	3.94	3.88	4.02	6642	6162	7271	111	104	121	18.3	16.2	19.8
934-2G	2816												
	2825	4.16	4.10	4.21	7197	6403	7991	114	113	116	19.4	18.8	19.9
934-2H	2816	5.10	4.93	5.47	8101	7678	8378	109	99	120	17.6	14.9	20.0
	2825	4.24	4.08	4.36	7860	7346	8272	125	106	141	16.0	10.7	18.4
935-2A	2816	5.61	5.14	5.88	4628	3316	5622	104	83	125	10.6	2.1	17.2
	2825	5.09	4.61	5.37	5101	3427	6816	108	85	127	8.7	1.3	15.0
951-2A	2816	7.06	6.80	7.30	6574	5814	7348	119	104	160	7.0	0.0	11.7
	2825	4.87	4.60	5.40	6456	5725	7209	126	112	165	4.9	-1.5	17.4
951-2B	2816	5.51	5.20	5.90	6658	6185	7244	117	105	128	7.0	-1.3	13.5
	2825	4.51	4.20	5.00	6541	6026	7034	127	101	157	5.6	-0.5	12.4
951-2C	2816	4.99	4.80	5.20	6933	6215	7274	110	89	142	13.4	3.0	18.9
	2825	3.80	3.50	4.20	6681	6156	7251	112	96	136	11.3	7.8	19.9
951-2D	2816	4.41	3.20	5.20	7178	6326	7961	109	95	133	8.2	-4.6	15.5
	2825	3.20	2.70	4.00	6967	6212	7822	117	111	127	5.4	-1.0	10.8
951-2E	2816	4.98	4.80	5.30	7000	5974	7644	104	83	125	12.2	-6.6	17.3
	2825	3.73	3.30	4.80	6753	5828	7555	113	79	139	9.6	4.6	16.9
976-2A	2816	6.61	3.60	7.80	5411	4626	6259	92	69	111	4.5	-13.4	15.1
	2825	4.92	4.80	5.80	6963	6308	7900	130	92	153	-9.4	-13.5	-4.9
976-2B	2816	7.03	6.70	7.30	5073	4689	5517	85	65	99	8.7	2.6	15.2
	2825	4.86	4.80	5.10	6634	5961	7043	117	64	163	-5.1	-13.4	12.7
977-2A	2816	6.96	6.70	7.40	5667	5196	6112	96	77	117	3.4	-2.4	8.1
	2825	4.87	4.60	5.20	6860	6314	7316	124	94	156	-6.5	-11.5	7.4
978-2A	2816	7.00	6.60	7.30	10727	10029	11924	124	108	144	4.3	-2.6	7.9
	2825	4.64	4.50	4.80	12141	10867	13717	138	82	187	-0.9	-12.3	7.7
979-2A	2816	7.22	6.80	7.60	8855	8377	9242	91	78	106	6.7	-0.5	11.6
	2825	4.57	4.40	4.70	10967	10396	11634	127	95	156	-3.1	-7.9	4.2
980-2A	2816	6.99	6.40	8.00	6521	5973	7303	79	55	110	6.8	-6.7	15.5
	2825	4.79	4.50	5.00	6603	5963	7659	99	72	142	7.3	1.0	15.8
981-2A	2816	6.58	5.60	7.00	6994	6179	7728	104	80	132	6.5	-2.6	12.2
	2825	4.58	4.40	4.90	7080	6298	8090	133	60	209	7.4	2.2	10.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
625-2A	2816	2.43	1.20	5.40	20.73	12.90	25.70	4.79	1.55	12.85	25.03	15.81	31.00	2.99	1.50	4.50	8.1	5.3	10.5
901-2A	2816	11.33	2.00	22.60	2.80	0.10	26.00	19.26	5.81	29.23	30.95	19.90	38.20	3.02	2.00	5.60	14.0	10.4	15.8
901-2H	2816	8.16	2.60	16.20	0.19	0.10	0.50	26.39	17.85	31.48	28.84	24.30	34.60	3.38	2.30	4.40	15.1	13.3	16.1
901-2I	2816	11.48	3.60	20.90	0.29	0.10	0.50	22.47	18.10	26.65	31.25	24.90	38.20	3.01	2.20	4.00	15.0	12.7	16.4
901-2J	2816	7.44	1.40	20.90	14.63	0.40	23.70	10.39	2.95	22.40	29.90	22.70	39.20	4.03	2.00	7.40	14.6	12.6	16.5
902-2A	2816	10.40	2.10	20.20	0.24	0.10	0.40	23.68	13.95	31.63	29.86	24.30	36.80	3.49	2.50	4.20	14.6	12.8	16.2
902-2B	2816	9.66	1.80	16.70	0.50	0.30	0.80	23.72	19.13	30.10	29.24	20.70	34.80	3.34	2.60	4.50	14.5	12.6	15.9
903-2A	2816	4.40	2.00	8.50	0.40	0.10	0.60	23.78	14.98	29.23	22.10	13.70	26.20	4.50	1.50	9.20	11.0	4.8	15.4
903-2B	2816	2.65	1.70	4.00	0.10	0.10	0.10	27.29	12.08	32.68	22.54	13.30	25.80	5.19	4.10	9.40	15.3	13.7	16.1
904-2A	2816	3.11	1.40	5.28	4.08	0.20	20.80	24.85	7.00	30.55	25.33	22.60	28.00	4.25	3.70	4.70	14.8	14.0	15.8
904-2B	2816	5.09	2.80	12.20	1.41	0.00	9.00	25.90	19.15	29.88	26.25	22.80	31.60	4.25	3.20	5.60	15.0	13.5	16.0
904-2C	2816	4.06	1.40	7.50	0.34	0.06	1.10	25.32	19.13	30.68	23.57	19.40	26.90	5.02	3.61	6.70	14.5	12.0	15.6
904-2D	2816	11.35	4.64	15.00	0.36	0.03	0.60	16.52	13.88	21.66	27.34	16.39	32.10	5.24	3.80	8.47	15.1	14.6	15.9
904-2E	2816	4.77	1.95	12.10	0.28	0.04	0.70	20.77	16.75	23.18	21.80	18.76	28.90	5.93	4.50	7.00	14.5	12.9	15.1
904-2F	2816	2.60	1.90	4.10	0.14	0.00	0.25	23.91	22.63	24.88	21.07	20.00	22.60	5.85	5.09	6.90	15.0	13.3	16.0
904-2G	2816	2.26	1.20	6.34	0.15	0.00	0.56	19.79	14.95	21.78	17.24	15.90	20.00	7.55	6.77	8.70	15.2	14.0	16.4
904-2H	2816	3.12	1.74	9.60	1.27	0.00	7.80	17.53	12.85	21.70	18.22	15.10	22.10	7.23	5.84	8.90	15.1	13.1	17.2
904-2I	2816	2.78	2.10	4.49	0.17	0.10	0.24	19.54	17.75	20.88	17.27	15.70	20.45	7.39	6.36	8.40	14.8	14.4	15.3
904-2J	2816	9.13	3.80	13.26	0.22	0.10	0.39	20.13	17.84	23.05	26.94	21.00	30.51	4.51	3.50	6.40	14.5	14.2	15.6
904-2K	2816	5.80	1.40	11.60	0.07	0.00	0.10	21.42	18.68	22.88	23.27	19.20	29.40	5.67	4.70	6.50	15.3	14.9	16.1
904-2L	2816	8.18	2.50	13.85	0.14	0.10	0.17	17.68	14.07	21.28	24.28	19.40	29.15	6.45	4.69	8.20	15.2	13.8	16.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
625-2A	2816	15.5	5.6	33.7	1.15	1.07	1.37	1.7	-7.7	8.1
901-2A	2816	88.4	15.2	99.6	2.13	1.11	4.17	1.7	-6.4	8.1
901-2H	2816	99.1	97.5	99.6	1.62	1.15	2.63	-0.1	-6.9	3.7
901-2I	2816	98.4	97.1	99.5	1.99	1.24	3.04	2.2	-3.8	7.4
901-2J	2816	42.5	15.2	97.8	1.68	1.06	3.21	1.2	-1.4	5.8
902-2A	2816	98.6	97.6	99.6	1.95	1.12	3.59	-0.9	-6.3	5.0
902-2B	2816	97.4	95.6	98.6	1.81	1.12	2.52	-0.5	-3.5	1.5
903-2A	2816	98.0	96.7	99.2	1.36	1.12	1.69	-0.3	-2.1	3.6
903-2B	2816	99.5	99.0	99.6	1.20	1.10	1.60	-0.2	-6.3	5.1
904-2A	2816	84.3	21.2	99.2	1.19	1.09	1.31	1.5	-4.3	6.0
904-2B	2816	94.0	63.4	100.0	1.35	1.18	2.12	1.4	-4.4	6.7
904-2C	2816	98.2	94.0	100.0	1.30	1.09	1.59	1.4	-7.5	7.9
904-2D	2816	97.3	95.1	99.8	2.26	1.39	2.89	3.2	-3.5	7.3
904-2E	2816	98.4	96.1	99.8	1.43	1.16	2.29	3.2	-0.5	7.7
904-2F	2816	99.3	98.8	100.0	1.20	1.14	1.32	4.1	-8.1	7.8
904-2G	2816	98.9	95.5	100.0	1.22	1.11	1.74	2.1	-2.4	4.9
904-2H	2816	92.4	57.6	100.0	1.32	1.16	2.28	4.6	-4.1	8.4
904-2I	2816	98.9	98.6	99.4	1.26	1.18	1.39	-0.8	-6.7	5.5
904-2J	2816	98.6	97.3	99.4	1.85	1.32	2.32	3.8	2.2	5.6
904-2K	2816	99.6	99.3	100.0	1.53	1.11	2.12	3.4	-1.5	6.8
904-2L	2816	99.0	98.5	99.4	1.99	1.21	2.76	5.7	5.1	6.3

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
904-2M	2816	14.50	14.50	14.50	0.10	0.10	0.10	14.68	14.68	14.68	29.60	29.60	29.60	4.90	4.90	4.90	15.9	15.9	15.9
904-2N	2816	12.52	6.10	17.50	0.42	0.30	4.52	18.10	13.88	21.80	30.30	24.41	33.70	4.26	3.69	4.50	15.0	13.0	16.8
904-2O	2816	6.87	5.40	7.82	0.26	0.10	0.39	20.95	19.53	23.18	24.95	24.20	25.54	5.00	4.80	5.30	15.0	14.7	15.4
904-2P	2816	8.22	3.90	14.90	1.74	0.30	4.32	18.58	15.05	23.43	25.69	21.90	31.20	5.11	4.60	5.80	14.2	13.2	15.3
904-2Q	2816	6.10	3.10	7.60	4.64	3.60	6.30	16.42	15.03	17.83	24.52	23.10	25.50	5.64	5.10	6.00	15.1	14.4	15.8
904-2R	2816	7.43	5.70	9.50	4.50	4.30	4.60	16.68	15.33	17.35	25.97	24.60	27.10	5.10	4.60	5.50	14.0	12.6	15.0
904-2S	2816	8.70	8.70	8.70	0.30	0.30	0.30	19.13	19.13	19.13	24.90	24.90	24.90	5.00	5.00	5.00	14.0	14.0	14.0
904-2U	2816	8.70	8.70	8.70	3.10	3.10	3.10	14.93	14.93	14.93	25.10	25.10	25.10	6.60	6.60	6.60	16.4	16.4	16.4
905-2A	2816	3.87	2.70	5.90	12.70	10.00	15.70	9.33	8.88	10.10	23.50	23.10	24.10	7.00	6.60	7.30	15.9	15.3	16.9
905-2B	2816	3.67	2.90	4.50	9.87	7.40	12.30	12.34	10.53	15.15	21.67	20.10	23.70	6.97	5.00	7.80	15.2	14.1	15.9
905-2C	2816	3.93	3.00	4.40	7.60	7.00	8.00	13.67	12.75	15.40	21.03	20.60	21.50	6.80	5.30	7.60	15.7	14.6	16.8
905-2D	2816	3.83	2.90	4.70	8.30	5.20	11.60	17.23	13.50	20.90	24.13	23.30	24.90	5.40	5.20	5.80	14.7	13.9	15.5
905-2E	2816	4.80	3.60	7.80	4.03	2.80	6.20	21.25	18.00	25.80	24.48	23.10	26.00	5.05	4.70	5.40	14.7	14.1	15.6
905-2F	2816	2.30	2.30	2.30	6.80	6.80	6.80	20.80	20.80	20.80	24.00	24.00	24.00	5.30	5.30	5.30	14.6	14.6	14.6
905-2G	2816																		
905-2H	2816	3.90	3.90	3.90	6.90	6.90	6.90	19.88	19.88	19.88	25.30	25.30	25.30	4.90	4.90	4.90	15.4	15.4	15.4
905-2I	2816	3.63	3.30	3.90	8.33	4.90	11.00	18.92	15.55	21.48	26.00	24.40	27.60	4.73	4.60	4.90	15.3	14.9	15.7
906-2A	2816	2.66	0.20	3.90	0.18	0.00	0.60	26.22	10.05	29.46	22.31	11.50	24.90	5.41	4.50	10.80	15.2	13.6	16.7
906-2B	2816	1.40	0.40	2.30	0.10	0.00	0.20	27.73	27.28	28.28	22.05	21.00	23.50	5.05	4.50	5.40	15.2	14.8	15.6
906-2C	2816	4.13	3.80	4.40	0.07	0.00	0.10	27.02	25.60	28.58	25.03	24.60	25.90	4.60	4.30	5.10	15.3	14.8	16.2
906-2D	2816	2.73	1.60	4.60	0.08	0.00	0.10	23.70	17.08	25.58	20.53	17.40	24.00	6.13	5.40	7.80	14.8	14.2	15.5

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
904-2M	2816	99.2	99.2	99.2	2.78	2.78	2.78	2.6	2.6	2.6
904-2N	2816	97.0	95.7	98.3	2.32	1.50	3.20	4.3	1.1	6.8
904-2O	2816	98.4	97.6	99.5	1.60	1.42	1.69	5.1	3.4	7.6
904-2P	2816	90.0	76.2	98.4	1.83	1.30	2.72	2.5	1.2	3.7
904-2Q	2816	74.1	68.5	78.5	1.51	1.23	1.68	4.9	0.2	7.1
904-2R	2816	74.7	74.0	75.1	1.61	1.45	1.83	3.4	1.8	4.7
904-2S	2816	98.1	98.1	98.1	1.81	1.81	1.81	0.6	0.6	0.6
904-2U	2816	79.4	79.4	79.4	1.84	1.84	1.84	3.4	3.4	3.4
905-2A	2816	37.5	31.2	41.9	1.29	1.17	1.50	3.9	-1.3	6.6
905-2B	2816	50.2	40.6	62.1	1.27	1.22	1.32	-1.3	-2.3	-0.7
905-2C	2816	58.9	56.9	69.6	1.31	1.21	1.37	-1.0	-4.1	3.9
905-2D	2816	62.5	48.2	76.3	1.25	1.19	1.31	-0.3	-2.8	1.8
905-2E	2816	80.8	70.3	86.6	1.35	1.23	1.66	-0.3	-5.3	3.8
905-2F	2816	71.0	71.0	71.0	1.14	1.14	1.14	2.3	2.3	2.3
905-2G	2816									
905-2H	2816	69.7	69.7	69.7	1.25	1.25	1.25	1.5	1.5	1.5
905-2I	2816	64.8	53.1	77.8	1.22	1.20	1.24	3.1	1.4	4.9
906-2A	2816	99.1	97.3	100.0	1.20	1.01	1.57	1.9	-7.7	7.9
906-2B	2816	99.6	99.1	100.0	1.10	1.03	1.15	3.4	1.3	6.1
906-2C	2816	99.7	99.5	100.0	1.28	1.27	1.30	3.1	0.3	7.4
906-2D	2816	99.6	99.3	100.0	1.22	1.11	1.49	1.7	-2.9	5.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
907-2A	2816	1.40	0.10	3.90	1.50	0.00	12.60	41.14	31.75	44.30	31.68	28.50	33.70	0.44	0.10	1.10	10.8	8.9	16.2
907-2B	2816	1.51	0.70	2.70	0.26	0.00	1.30	43.39	39.78	46.50	32.26	31.60	33.90	0.34	0.20	0.50	10.1	9.8	11.1
907-2C	2816	11.99	2.10	17.00	0.18	0.00	0.50	31.95	26.60	40.98	37.55	31.60	40.70	0.30	0.20	0.80	9.9	9.1	10.5
907-2D	2816	7.96	0.70	16.40	0.07	0.00	0.20	36.07	29.60	43.58	35.73	31.00	39.60	0.27	0.10	0.50	10.3	9.3	11.9
907-2E	2816	8.34	5.00	14.70	0.08	0.00	0.40	36.40	27.20	39.50	35.46	33.40	37.50	0.29	0.20	0.40	9.3	4.3	11.7
907-2F	2816	4.03	1.70	6.50	0.05	0.00	0.20	40.71	36.50	43.70	34.01	32.80	35.60	0.26	0.20	0.30	9.7	9.1	10.2
907-2G	2816	1.91	0.50	5.10	0.07	0.00	0.30	42.97	39.60	44.50	32.28	31.20	34.60	0.42	0.20	0.60	9.9	9.0	10.9
907-2J	2816	3.70	0.30	17.10	0.24	0.00	3.50	40.31	17.50	45.58	33.28	30.30	37.50	0.57	0.10	2.00	9.6	5.4	11.1
907-2K	2816	1.40	0.40	4.30	0.65	0.00	0.10	43.88	38.98	45.46	32.81	31.60	35.10	0.33	0.20	0.50	10.3	9.4	11.1
907-2L	2816	2.51	0.30	4.70	0.07	0.00	0.50	42.50	40.88	44.50	33.52	31.60	35.50	0.33	0.20	0.60	10.1	9.5	10.9
907-2M	2816	8.44	2.60	19.50	0.66	0.00	6.20	34.94	22.78	43.00	36.45	33.00	42.60	0.37	0.30	0.60	9.9	9.0	11.0
926-2A	2816	3.63	1.20	6.60	18.83	14.70	25.00	3.34	0.73	5.80	23.07	18.50	27.60	6.39	5.20	7.90	15.1	13.7	16.4
927-2A	2816	2.41	0.60	7.00	16.34	6.50	21.20	4.55	1.55	10.98	20.68	14.00	25.30	6.98	5.60	8.70	14.6	13.0	16.2
928-2A	2816	2.85	1.10	6.30	20.83	16.40	24.10	4.40	1.48	8.90	25.39	22.10	27.80	5.73	4.90	7.10	14.9	13.3	16.6
929-2A	2816	3.69	2.40	5.10	19.23	15.10	23.10	2.72	1.48	4.03	24.07	21.00	28.70	6.01	5.00	7.00	14.5	13.6	16.3
930-2A	2816	5.26	3.20	7.70	19.83	13.80	24.20	3.64	1.65	7.10	26.42	22.10	30.30	5.81	4.40	9.20	15.0	14.0	15.7
931-2A	2816	1.06	0.10	2.10	17.70	11.50	23.30	6.56	3.18	11.60	21.51	18.10	25.10	6.00	4.70	7.60	13.9	13.0	15.8
932-2A	2816	3.37	0.90	6.70	18.50	3.40	25.80	5.68	1.80	17.40	24.74	15.40	30.10	5.58	3.90	7.50	14.6	11.3	15.9
933-2A	2816	3.09	1.50	9.20	16.43	13.10	22.10	6.55	3.38	10.10	23.40	19.70	26.90	5.68	4.30	7.30	13.8	11.7	16.2
934-2A	2816	0.89	0.00	3.80	11.11	0.00	25.80	30.78	19.46	39.83	32.30	27.20	36.40	0.54	0.30	0.70	8.0	2.2	10.8
934-2B	2816	0.59	0.20	2.50	22.06	19.00	25.50	22.17	17.05	25.85	35.67	29.80	37.30	0.36	0.20	0.50	10.0	9.1	10.6

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
907-2A	2816	95.9	66.8	100.0	1.06	1.00	1.18	-0.8	-6.2	5.7
907-2B	2816	99.2	96.1	100.0	1.06	1.03	1.12	-0.9	-3.2	1.3
907-2C	2816	99.3	98.1	100.0	1.72	1.09	2.16	-0.7	-4.5	7.3
907-2D	2816	99.8	99.2	100.0	1.42	1.03	2.01	0.8	-5.8	8.1
907-2E	2816	99.8	98.7	100.0	1.43	1.25	1.98	-2.0	-6.3	4.5
907-2F	2816	99.9	99.4	100.0	1.18	1.07	1.32	0.9	-2.0	4.5
907-2G	2816	99.8	99.1	100.0	1.08	1.02	1.23	-1.0	-4.8	3.9
907-2J	2816	99.3	89.3	100.0	1.22	1.01	2.78	0.4	-2.1	7.1
907-2K	2816	99.9	99.7	100.0	1.06	1.02	1.20	0.7	-2.1	6.4
907-2L	2816	99.8	98.5	100.0	1.11	1.01	1.20	1.5	-1.9	5.3
907-2M	2816	97.5	78.1	100.0	1.50	1.11	2.48	1.8	-0.6	6.4
926-2A	2816	12.5	3.1	19.6	1.25	1.09	1.42	-1.6	-7.1	7.1
927-2A	2816	19.1	6.0	57.5	1.18	1.04	1.72	0.4	-8.3	7.7
928-2A	2816	14.4	5.2	30.3	1.18	1.06	1.48	1.7	-3.4	7.1
929-2A	2816	10.3	5.5	17.2	1.25	1.14	1.33	2.5	-3.1	8.2
930-2A	2816	13.0	5.5	24.0	1.34	1.19	1.54	-0.7	-7.7	7.2
931-2A	2816	23.6	10.3	42.8	1.07	1.01	1.12	0.3	-4.6	6.2
932-2A	2816	21.0	6.2	74.6	1.22	1.06	1.95	1.0	-6.4	8.0
933-2A	2816	24.2	10.9	35.3	1.21	1.09	1.74	2.2	-3.4	7.5
934-2A	2816	71.7	37.6	100.0	1.04	1.00	1.10	-0.5	-5.9	2.5
934-2B	2816	44.6	38.6	52.1	1.02	1.01	1.10	0.2	-1.7	1.7

RUN SUMMARY - SOLIDS ANALYTICAL DATA

CONCENTRATIONS IN SOLIDS, WT %

RUN NO.	ANALYTICAL POINT	CO2 AVG	CO2 MIN	CO2 MAX	SO2 AVG	SO2 MIN	SO2 MAX	SO3 AVG	SO3 MIN	SO3 MAX	CAO AVG	CAO MIN	CAO MAX	ACID INSOLUBLES AVG	ACID INSOLUBLES MIN	ACID INSOLUBLES MAX	SOLIDS IN SLURRY, WT % AVG	SOLIDS IN SLURRY, WT % MIN	SOLIDS IN SLURRY, WT % MAX
934-2C	2816	2.44	0.50	17.43	20.92	0.20	29.40	21.70	15.41	32.25	36.62	32.30	40.70	0.48	0.30	1.10	9.9	7.9	11.8
934-2D	2816	1.31	0.80	4.30	29.63	20.60	35.40	14.85	8.96	23.90	38.34	35.70	39.20	0.40	0.20	0.50	10.0	8.7	11.0
934-2E	2816	0.40	0.20	0.90	25.95	21.90	28.40	20.28	17.51	24.63	37.17	34.40	38.20	0.33	0.30	0.50	9.9	9.3	11.5
934-2F	2816	0.44	0.10	1.60	21.71	19.10	26.80	23.85	19.50	27.00	35.49	33.40	38.20	0.37	0.20	0.60	9.5	8.7	10.4
934-2G	2816	0.53	0.30	1.30	30.71	23.60	34.60	15.31	12.08	23.10	38.17	37.50	39.60	0.47	0.20	0.70	10.0	9.3	10.8
934-2H	2816	0.64	0.30	1.90	33.45	27.40	37.90	12.50	6.33	18.96	38.84	38.00	40.00	0.47	0.30	0.70	10.2	9.7	11.1
935-2A	2816	2.91	1.00	5.10	19.39	10.80	23.70	6.55	1.48	12.60	25.85	21.00	29.40	6.03	5.30	7.10	15.4	14.5	16.8
951-2A	2816	1.40	0.80	1.90	15.01	12.00	21.00	13.36	8.45	16.43	24.93	22.80	26.60	2.64	2.10	3.50	8.5	7.2	9.2
951-2B	2816	0.78	0.20	2.40	3.96	0.30	10.80	25.44	15.48	29.68	22.45	18.80	26.40	2.63	2.00	4.10	8.1	7.0	9.0
951-2C	2816	0.53	0.20	1.50	1.13	0.40	2.20	28.99	26.15	32.43	22.41	20.60	26.40	2.45	2.10	2.80	8.2	7.6	8.8
951-2D	2816	0.43	0.10	1.10	0.88	0.20	1.80	27.26	21.35	30.63	20.40	16.80	22.50	2.78	2.10	3.60	7.8	6.5	8.8
951-2E	2816	0.55	0.10	1.10	0.78	0.10	2.20	27.42	25.05	28.98	21.02	20.00	23.40	2.73	2.00	3.40	7.8	6.4	9.8
976-2A	2816	1.43	0.90	3.20	19.53	16.50	21.80	4.15	0.38	9.28	21.48	20.10	22.60	6.78	6.10	7.90	14.9	13.7	17.1
976-2B	2816	1.16	0.70	1.80	19.54	16.60	21.90	3.17	1.30	6.58	21.18	17.40	23.10	3.70	3.30	4.60	8.1	7.5	8.5
977-2A	2816	1.36	0.60	2.50	20.68	16.50	25.60	2.83	0.83	6.95	21.58	19.00	26.00	3.53	2.60	4.20	8.0	6.9	9.0
978-2A	2816	1.50	1.00	2.00	19.74	16.30	24.20	6.56	4.23	8.90	24.21	22.00	27.60	3.18	2.20	4.20	8.1	6.8	9.9
979-2A	2816	1.74	0.80	2.80	24.68	21.60	26.80	4.91	2.78	6.58	26.98	24.30	28.70	2.74	2.00	3.60	8.1	6.1	9.0
980-2A	2816	2.10	0.90	5.20	24.16	21.00	29.30	3.88	1.80	7.43	27.07	24.60	31.00	2.72	1.80	3.50	8.2	6.7	9.9
981-2A	2816	1.77	1.10	3.30	21.51	20.20	23.50	2.54	1.90	3.15	23.44	21.40	25.10	3.48	3.10	4.20	8.4	7.8	10.2

RUN SUMMARY - SOLIDS ANALYTICAL DATA (CONTINUED)

RUN NO.	ANALYTICAL POINT	PERCENT SULFITE OXIDATION AVG	MIN	MAX	STOICHIOMETRIC RATIO AVG	MIN	MAX	PERCENT IONIC IMBALANCE AVG	MIN	MAX
934-2C	2816	47.2	29.7	99.2	1.13	1.02	2.20	-0.1	-7.5	3.1
934-2D	2816	28.8	16.8	44.4	1.05	1.03	1.18	0.9	-2.3	4.1
934-2E	2816	38.5	33.7	47.4	1.01	1.01	1.03	-0.8	-7.7	2.4
934-2F	2816	46.8	38.6	52.4	1.01	1.00	1.05	-2.2	-5.9	0.6
934-2G	2816	28.5	22.6	43.9	1.02	1.01	1.04	-0.3	-3.2	2.2
934-2H	2816	23.0	11.8	35.6	1.02	1.01	1.06	-0.1	-3.9	2.2
935-2A	2816	21.7	4.8	48.3	1.17	1.06	1.29	2.2	-5.8	6.3
951-2A	2816	41.9	24.4	50.9	1.08	1.05	1.11	2.5	-1.8	5.4
951-2B	2816	83.8	59.9	98.6	1.05	1.01	1.19	0.4	-7.6	8.2
951-2C	2816	95.3	90.5	98.3	1.03	1.01	1.09	1.9	-7.0	7.2
951-2D	2816	96.1	92.7	99.1	1.03	1.01	1.07		-6.6	4.3
951-2E	2816	96.6	90.7	99.6	1.04	1.01	1.07	2.0	-6.1	8.1
976-2A	2816	14.4	1.4	27.7	1.09	1.06	1.22	-1.6	-8.5	2.5
976-2B	2816	11.3	4.7	22.9	1.06	1.04	1.12	1.6	-7.6	8.4
977-2A	2816	10.1	2.9	24.7	1.09	1.04	1.16	-1.2	-8.3	6.1
978-2A	2816	21.0	13.7	28.8	1.09	1.06	1.13	1.7	-3.6	6.1
979-2A	2816	13.7	8.1	17.0	1.09	1.04	1.16	-1.2	-6.9	4.3
980-2A	2816	11.3	5.4	29.9	1.11	1.05	1.26	2.0	-6.8	8.1
981-2A	2816	8.7	6.2	10.7	1.11	1.07	1.20	2.4	-8.0	7.7

APPENDIX E

TEST RESULTS SUMMARY TABLES FOR THE VENTURI/SPRAY TOWER AND SPRAY TOWER SYSTEMS

Table E-1

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE TESTS WITH TWO-SCRUBBER-LOOP FORCED OXIDATION AND BACKMIX -WIDOWS CREEK SIMULATION-

Run Number	827-1A	828-1A	828-1B	829-1A
Start-of-Run Date	2/14/79	3/12/79	3/13/79	3/16/79
End-of-Run Date	3/12/79	3/13/79	3/15/79	3/21/79
On Stream Hours	345	29	48	106
Fly Ash Loading	High	High	High	High
Adipic Acid Addition	No	No	No	No
Gas Rate, acfm @ 300°F	35,000	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	21	21	21	21
Spray Tower Liquor Rate, gpm	1500	1500	1500	1500
Spray Tower L/G, gal/Mcf	53	53	53	53
Venturi Percent Solids Recirculated	11.7 - 13.3	11.6 - 12.4	11.1 - 13.3	11.5 - 13.3
Spray Tower Percent Solids Recirculated	9.7 - 11.7	10.6	9.7 - 11.5	9.4 - 11.6
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	9.4	9.4	9.4	9.4
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.41 - 1.93	2.14 - 2.24	1.38 - 1.57	1.28 - 1.55
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.53 - 2.51	2.52 - 2.72	1.97 - 2.25	1.47 - 1.83
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	60	46	68	70
Inlet O_2 Concentration, vol. %	3.0 - 4.6	3.2 - 4.2	3.6 - 4.6	3.0 - 4.8
Inlet SO_2 Concentration, ppm	2600 - 3000	2300 - 2900	2500 - 3000	2600 - 3100
Overall Percent SO_2 Removal	68 - 82	80 - 86	55 - 63	74 - 84
Average SO_2 Make-Per-Pass, m-mole/l	7.4	7.6	5.7	8.0
Venturi Inlet pH Range	5.35 - 5.65	5.5 - 5.6	5.1 - 5.4	5.35 - 5.75
Venturi Outlet pH Range	4.7 - 5.1	4.9 - 5.0	4.7 - 4.9	4.7 - 5.2
Spray Tower Inlet pH Range	5.45 - 5.75	5.6 - 5.7	4.8 - 5.2	5.6 - 5.9
Spray Tower Outlet pH Range	-	-	-	-
Percent Sulfite Oxidized in Venturi Inlet Slurry	96.5 - 99.5	97.5 - 98.5	98 - 99	83 - 90
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	62 - 81	65 - 75	88 - 98	57 - 72
Air Flow Rate to Oxidizer, scfm	250	180	180	145
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.10	1.45	1.95	1.15
Solids in Sludge Discharged, %	81 - 88	83 - 85	79 - 88	73 - 84
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	95	95	95
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	100	95	115	90
Total Dissolved Solids in Venturi Inlet Liquor, ppm	6275 - 7995	8345 - 9005	9845 - 10,205	9660 - 10,850
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	6235 - 8155	8205 - 8645	11,520 - 12,650	8950 - 10,090
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	15.0 - 16.6	14.9 - 15.7	14.7 - 15.6	14.3 - 16.1
Venturi ΔP (nominal), in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.59 - 0.72	0.62 - 0.67	0.61 - 0.71	0.60 - 0.69
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-1 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE TESTS WITH TWO-SCRUBBER-LOOP FORCED OXIDATION AND BACKMIX -WIDOWS CREEK SIMULATION-

Run Number	827-1A	828-1A	828-1B	829-1A
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow about 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow about 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow about 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow about 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Widows Creek (Stoneman) limestone slurried to 60 wt% with makeup water and added to spray tower EHT.	Widows Creek (Stoneman) limestone slurried to 60 wt% with makeup water and added to spray tower EHT.	Widows Creek (Stoneman) limestone slurried to 60 wt% with makeup water and added to spray tower EHT.	Widows Creek (Stoneman) limestone slurried to 60 wt% with makeup water and added to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Major maintenance on venturi scrubber. Modified the system for Widows Creek two-loop oxidation simulation. Installed backmixing piping from venturi effluent to spray tower EHT. Switched from limestone and adipic acid to limestone only operation. Cleaned the cross-over line and I.D. fan. Dumped all slurry. Switched to Widows Creek coal and limestone.	(No shutdown)	(No shutdown)	Performed maintenance on I.D. fan.
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to the spray tower EHT. Spray tower pH was uncontrolled. Venturi and spray tower slurry solids controlled at 12% and 10%, respectively. Backmixing rate held at 65 gpm.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to the spray tower EHT. Spray tower pH was uncontrolled. Venturi and spray tower slurry solids controlled at 12% and 10%, respectively. Backmixing rate held at 65 gpm.	Venturi limestone stoichiometric ratio controlled at 1.3 by limestone addition to the spray tower EHT. (Override: venturi inlet pH not less than 5.2). Venturi and spray tower slurry solids controlled at 12% and 10%, respectively. Backmixing rate held at 65 gpm.	Venturi inlet pH controlled at 5.5 ± 0.2 by limestone addition to the spray tower EHT. Spray tower pH was uncontrolled. Venturi and spray tower slurry solids controlled at 12% and 10%, respectively. Backmixing rate held at 65 gpm.
Run Philosophy	The objective of this test was to simulate the planned Widows Creek full-scale operation with two-scrubber-loop forced oxidation. The Widows Creek coal (Pittsburgh Midway) and limestone (Stoneman) were used for the simulation. The major concern of this run was to obtain high sulfite oxidation.	The purpose of this run was to operate with the Widows Creek configuration and operating conditions with the air rate to the sparger reduced from 250 to 180 scfm.	The purpose of this run was the same as the previous run, 828-1A. Control was changed from pH to limestone stoichiometric ratio to reduce limestone consumption.	The purpose of this run was to reduce the air rate to the sparger even further, from 180 to 145 scfm in an attempt to determine the system's air requirements for oxidation. Operation continued with the Widows Creek configuration and operating conditions.
Results	SO_2 removal averaged 75% at 2800 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The filter cake solids content averaged 85%.	SO_2 removal averaged 83% at 2600 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The filter cake solids content averaged 84%.	SO_2 removal averaged 59% at 2750 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98.5%. The filter cake solids content averaged 84%. The mist eliminator was entirely free of scale but about 1% restricted from fallout solids from outlet duct.	SO_2 removal averaged 79% at 2850 ppm average inlet SO_2 concentration. Average sulfite oxidation was 87%. The filter cake solids content averaged 79%.

Table E-1 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE TESTS WITH TWO-SCRUBBER-LOOP FORCED OXIDATION AND BACKMIX -WIDOWS CREEK SIMULATION-

Run Number	830-1A	
Start-of-Run Date	3/22/79	
End-of-Run Date	3/30/79	
On Stream Hours	181	
Fly Ash Loading	High	
Adipic Acid Addition	No	
Gas Rate, acfm @ 300°F	35,000	
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	
Venturi Liquor Rate, gpm	600	
Venturi L/G, gal/Mcf	21	
Spray Tower Liquor Rate, gpm	1500	
Spray Tower L/G, gal/Mcf	53	
Venturi Percent Solids Recirculated	10.4 - 13.0	
Spray Tower Percent Solids Recirculated	8.7 - 11.1	
Venturi Oxidation Tank Residence Time, min.	11.3	
Venturi Desupersaturation Tank Residence Time, min.	4.7	
Spray Tower Effluent Residence Time, min.	9.4	
Solids Disposal System	Clarifier & Filter	
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.47 - 2.09	
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	2.10 - 2.66	
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	56	
Inlet O_2 Concentration, vol. %	3.5 - 5.7	
Inlet SO_2 Concentration, ppm	2200 - 3000	
Overall Percent SO_2 Removal	84 - 94	
Average SO_2 Make-Per-Pass, m-mole/l	8.2	
Venturi Inlet pH Range	5.8 - 6.2	
Venturi Outlet pH Range	5.1 - 5.5	
Spray Tower Inlet pH Range	5.9 - 6.3	
Spray Tower Outlet pH Range	-	
Percent Sulfite Oxidized in Venturi Inlet Slurry	88.5 - 98.5	
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	43 - 67	
Air Flow Rate to Oxidizer, scfm	250	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.90	
Solids in Sludge Discharged, %	72 - 86	
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	90	
Total Dissolved Solids in Venturi Inlet Liquor, ppm	8810 - 9600	
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	7755 - 9115	
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	13.9 - 17.3	
Venturi ΔP (nominal), in. H_2O	9	
Mist Elimination System ΔP Range, in H_2O	0.48 - 0.70	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	

Table E-1 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE TESTS WITH TWO-SCRUBBER-LOOP FORCED OXIDATION AND BACKMIX
-WIDOWS CREEK SIMULATION-

Run Number	830-1A	
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow about 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	
Absorbent	Widows Creek (Stoneman) limestone slurried to 60 wt% with makeup water and added to spray tower EHT.	
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	
System Changes Before Start of Run	No cleaning. Installed tee in inlet flue gas duct for later tie-in to Unit 9 boiler.	
Method of Control	Venturi inlet pH controlled at 6.0 ± 0.2 by limestone addition to the spray tower EHT. Spray tower pH was uncontrolled. Venturi and spray tower slurry solids controlled at 12% and 10%, respectively. Backmixing rate held at 29 gpm.	
Run Philosophy	The purpose of this run was to determine the effects of increased venturi inlet pH (from 5.5 to 6.0) and reduced backmix rate (from 65 to 29 gpm) on oxidation and SO_2 removal while operating with Widows Creek configuration and operating conditions.	
Results	SO_2 removal averaged 89% at 2600 ppm average inlet SO_2 concentration. Average sulfite oxidation was 94%. The filter cake solids content averaged 79%.	

Table E-2

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIMESTONE SLURRY

Run Number	901-1A	902-1A	902-1B	903-1A
Start-of-Run Date	7/12/78	8/3/78	8/22/78	8/28/78
End-of-Run Date	7/20/78	8/20/78	8/25/78	9/5/78
On Stream Hours	187	373	65	183
Fly Ash Loading	High	High	High	High
Adipic Acid Addition	No	Yes	Yes	Yes
Gas Rate, acfm @ 300°F	35,000	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	21	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600 (intermittent)	0
Spray Tower L/G, gal/Mcf	57	57	57	0
Venturi Percent Solids Recirculated	14.6 - 16.4	13.4 - 17.6	13.3 - 16.5	14.0 - 16.0
Spray Tower Percent Solids Recirculated	4.8 - 7.0	3.5 - 6.3	4.7 - 4.9	-
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	14.7	14.7	14.7	-
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.05	1.01 - 1.11	1.01 - 1.03	1.17 - 1.55
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.26 - 1.46	1.02 - 2.28	1.26 - 1.50	-
Overall Avg. % Limestone Utilization 100 x moles SO_2 abs./mole Ca added	97	94	98	74
Inlet O_2 Concentration, vol. %	5.0 - 8.0	6.0 - 7.0	5.0 - 7.0	4.5 - 9.0
Inlet SO_2 Concentration, ppm	2600 - 3000	1600 - 3300	2200 - 2600	2000 - 3200
Overall Percent SO_2 Removal	48 - 66	84 - 98	82 - 96 (12 - 48, Venturi only)	41 - 65
Average SO_2 Make-per-pass, m-mole/l	5.5	7.5	7.2	16.5
Venturi Inlet pH Range	4.2 - 4.8	3.80 - 5.10	3.70 - 4.30	4.55 - 4.85
Venturi Outlet pH Range	3.0 - 4.5	2.70 - 4.60	2.80 - 3.50	4.30 - 4.50
Spray Tower Inlet pH Range	5.2 - 5.7	4.80 - 5.70	4.90 - 5.20	-
Spray Tower Outlet pH Range	5.2 - 5.4	4.70 - 5.50	4.90 - 5.10	-
Percent Sulfite Oxidized in Venturi Inlet Slurry	97 - 99	97 - 99	98 - 100	97 - 99
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	18 - 38	16 - 64	16 - 38	-
Air Flow Rate to Oxidizer, scfm	210	260	260	210
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.30	2.05	2.15	2.65
Solids in Sludge Discharged, %	82 - 88	80 - 92	85 - 91	77 - 89
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	95	100	90	100
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	95	110	115	-
Total Dissolved Solids in Venturi Inlet Liquor, ppm	7200 - 8600	9400 - 13,600	11,300 - 14,300	14,000 - 17.100
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	5000 - 7200	8000 - 11,100	9800 - 11,400	-
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	15.4 - 16.9	15.2 - 18.5	15.5 - 16.9	13.7 - 14.6
Venturi ΔP (nominal), in. H_2O	9	9	9	9
Mist Elimination System ΔP Range, in. H_2O	0.60 - 0.68	0.58 - 0.76	0.59 - 0.69	0.58 - 0.64
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-2 (continued)

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIMESTONE SLURRY

Run Number	901-1A	902-1A	902-1B	903-1A
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to spray tower hold tank.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. Adipic acid dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT. Adipic acid dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to the desupersaturation tank. Adipic acid was dry fed to spray tower EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Venturi only operation. Spray tower slurry recirculation pumps (G-101 and G-204) turned off.
System Changes Before Start of Run	Switched from lime to limestone. No other changes. No cleaning.	Switched from lime to limestone. No other changes. No cleaning.	No changes. No cleaning.	No. Changes. No cleaning.
Method of Control	Spray tower limestone stoichiometric ratio controlled at 1.4. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to spray tower EHT.	Spray tower limestone stoichiometric ratio controlled at 1.4. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to spray tower EHT. Adipic acid concentration in spray tower controlled at 1500 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.4. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to spray tower EHT. Adipic acid concentration in spray tower controlled at 1500 ppm.	Venturi only operation. Venturi limestone stoichiometric ratio controlled at 1.3. Venturi recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration in the venturi controlled at 3500 ppm.
Run Philosophy	A base case two-stage forced oxidation limestone run without adipic acid. The results will be compared with succeeding limestone/adipic acid runs to observe the effect of adipic acid on SO_2 removal.	The objective was to observe the effects of 1500 ppm adipic acid concentration in the spray tower and about 2000 ppm in the venturi on the SO_2 removal (cf. Run 901-1A without adipic acid addition).	Same as 902-1A except that the spray tower slurry recirculation pumps (G-101 and G-204) were turned off for 30 minutes every 8 hours to determine SO_2 removal by the venturi scrubber alone.	The objective was to observe whether reasonably high SO_2 removal could be achieved with venturi alone and with 3500 ppm adipic acid in the slurry liquor.
Results	SO_2 removal averaged 57% at 2800 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The filter cake solids content averaged 85%. The mist eliminator was 0.2% restricted at the end of the run.	SO_2 removal averaged 91% at 2450 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The adipic acid concentration averaged 2045 ppm in the venturi and 1445 ppm in the spray tower. The filter cake solids content averaged 86%. The mist eliminator was 0.2% restricted at the end of the run.	SO_2 removal averaged 89% (30% with venturi only operation) at 2400 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99%. The adipic acid concentration averaged 2355 ppm in the venturi and 1615 ppm in the spray tower. The filter cake solids content averaged 88%.	SO_2 removal averaged 53% at 2600 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The adipic acid concentration in the venturi loop averaged 3510 ppm. The filter cake solids content averaged 83%. The scrubber was not shutdown at the end of the run.

Table E-2 (continued)

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIMESTONE SLURRY

Run Number	904-1A	905-1A	906-1A	907-1A
Start-of-Run Date	9/5/78	9/8/78	9/27/78	10/8/78
End-of-Run Date	9/8/78	9/27/78	10/3/78	11/13/78
On Stream Hours	72	439	153	719
Fly Ash Loading	High	High	High	High
Adipic Acid Addition	Yes	Yes	Yes	Yes
Gas Rate, acfm @ 300°F	18,000	35,000	35,000	18,000 - 35,000
Spray Tower Gas Vel., ft/sec @ 125°F	4.8	9.4	9.4	4.8 - 9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	42	21	21	21 - 42
Spray Tower Liquor Rate, gpm	0	1600	1600	1600
Spray Tower L/G, gal/Mcf	0	57	57	57 - 111
Venturi Percent Solids Recirculated	11.0 - 13.6	13.7 - 15.5	13.8 - 16.0	13.6 - 16.2
Spray Tower Percent Solids Recirculated	-	2.3 - 4.1	5.6 - 8.0	3.8 - 8.3
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	11.3	11.3
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	4.7	4.7
Spray Tower Effluent Residence Time, min.	-	14.7	14.7	14.7
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.17 - 1.47	1.01 - 1.19	1.08 - 1.18	1.01 - 1.25
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	-	1.26 - 1.80	1.34 - 1.64	1.44 - 2.10
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	76	91	88	88
Inlet O_2 Concentration, vol. %	2.0 - 6.5	-	-	4.0 - 8.0
Inlet SO_2 Concentration, ppm	1500 - 3200	1500 - 2900	2100 - 3300	1300 - 3400
Overall Percent SO_2 Removal	56 - 78	75 - 97	89 - 97	96 - 99%
Average SO_2 Make-per-pass, m-mole/l	10.0	6.4	8.5	2 - 11
Venturi Inlet pH Range	4.6 - 4.9	4.45 - 4.65	4.3 - 4.7	4.4 - 4.9
Venturi Outlet pH Range	4.3 - 4.5	3.8 - 4.6	4.0 - 4.3	3.8 - 4.7
Spray Tower Inlet pH Range	-	4.5 - 5.0	4.85 - 5.45	5.1 - 5.8
Spray Tower Outlet pH Range	-	-	-	4.9 - 5.7
Percent Sulfite Oxidized in Venturi Inlet Slurry	97 - 99	97.5 - 99.5	98 - 99	97.5 - 99.5
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	-	29 - 97	20 - 36	7 - 51
Air Flow Rate to Oxidizer, scfm	130	260	260	260
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.80	2.40	1.80	2.0 - 3.85
Solids in Sludge Discharged, %	75 - 85	82 - 88	78 - 90	82 - 92
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	100	100	110	110
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	-	130	100	105
Total Dissolved Solids in Venturi Inlet Liquor, ppm	14,600 - 16,200	15,500 - 18,100	17,100 - 21,100	12,200 - 18,700
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	-	12,800 - 15,600	11,000 - 13,400	8400 - 12,800
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	9.6 - 10.6	15.5 - 17.1	15.1 - 16.9	4.6 - 16.6
Venturi ΔP (nominal), in. H_2O	9	9	9	3.0 - 9.6
Mist Elimination System ΔP Range, in. H_2O	0.18 - 0.23	0.55 - 0.68	0.58 - 0.64	0.13 - 0.69
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.

Table E-2 (continued)

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIMESTONE SLURRY

Run Number	904-1A	905-1A	906-1A	907-1A
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the desupersaturation tank. Adipic acid was dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT and desupersaturation tank. Adipic acid dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT and desupersaturation tank. Adipic acid dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT and desupersaturation tank. Adipic acid dry fed to spray tower EHT.
Scrubber Internals	Venturi only operation. Spray tower slurry recirculation pumps (G-101 and G-204) turned off.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	(No shutdown)	No changes. No cleaning.	No changes. No cleaning.	Cleaned I.D. Fan and damper. Replaced venturi plug support shaft. Installed a corrosion coupon rack in spray tower on trap-out tray's reflector plate.
Method of Control	Venturi only operation. Venturi limestone stoichiometric ratio controlled at 1.3. Venturi recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration in the venturi controlled at 3500 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.45 by limestone addition to spray tower EHT. Venturi inlet pH controlled at 4.5 by separate limestone addition to desupersat'n tank. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to spray tower EHT. Adipic acid concentration in spray tower controlled at 1500 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.70 by limestone addition to spray tower EHT. Venturi inlet pH controlled at 4.5 by separate limestone addition to desupersat'n tank. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor in excess of mist eliminator wash returned to spray tower EHT and oxidation tank to control spray tower slurry solids at 6-7%. Adipic acid concentration in spray tower controlled at 1500 ppm.	Spray tower limestone stoichiometric ratio controlled at 1.7 by limestone addition to the S.T. EHT. (Override: S.T. inlet pH not less than 5.1). Venturi inlet pH controlled at 4.5 by separate limestone addition to the desupersat'n tank. Venturi recirculated slurry solids controlled at 15±1%. Clarified liquor in excess of mist eliminator wash returned to S.T. EHT and oxid. tank to control S.T. slurry solids at 6%. Adipic acid in S.T. controlled at 1500 ppm. Venturi plug position fixed to give 9 in. H20 ΔP at 35,000 acfm gas rate. Gas rate was varied with No. 10 Boiler load.
Run Philosophy	The objective was to observe the effect of increased L/G (reduced gas rate) on SO_2 removal) with venturi only operation (cf. Run 903-1A).	The objective was to observe the effect of higher venturi inlet pH on SO_2 removal (effect of separate limestone addition to the venturi loop) (cf. Run 902-1A and 902-1B).	The objective was to achieve better than 90% SO_2 removal with 1500 ppm adipic acid in spray tower loop and a limestone stoichiometric ratio of 1.70 in the spray tower. Spray tower slurry solids was increased to obtain higher spray tower inlet pH.	This was a one-month reliability test. The objective was to obtain greater than 90 percent SO_2 removal with adipic acid additive, and to have an operation free of scaling and plugging during one month of testing.
Results	SO_2 removal averaged 67% at 2350 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The adipic acid concentration in the venturi loop averaged 3690 ppm. The filter cake solids content averaged 80%. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 86% at 2200 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99%. The adipic acid concentration averaged 2315 ppm in the venturi and 1410 ppm in the spray tower. The filter cake solids content averaged 85%. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 93% at 2700 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98.5%. The adipic acid concentration averaged 2495 ppm in the venturi and 1485 ppm in the spray tower. The filter cake solids content averaged 84%. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 97.5% at 2350 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98.5%. The adipic acid concentration averaged 2360 ppm in the venturi and 1560 ppm in the spray tower. The filter cake solids content averaged 87%. The mist eliminator was entirely clean at the end of the run and fallout solids on the mist eliminator were negligible The entire scrubber system was free of scaling and plugging.

Table E-2 (continued)

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIMESTONE SLURRY

Run Number	907-1B	908-1A	
Start-of-Run Date	11/13/78	1/29/79	
End-of-Run Date	1/29/79	2/3/79	
On Stream Hours	1666	119	
Fly Ash Loading	High	High	
Adipic Acid Addition	Yes	Yes	
Gas Rate, acfm @ 300°F	20,000 - 35,000	33,000	
Spray Tower Gas Vel., ft/sec @ 125°F	5.4 - 9.4	88	
Venturi Liquor Rate, gpm	600	600	
Venturi L/G, gal/Mcf	21 - 37	23	
Spray Tower Liquor Rate, gpm	1600	1600	
Spray Tower L/G, gal/Mcf	57 - 100	60	
Venturi Percent Solids Recirculated	11.8 - 17.8	13.9 - 15.5	
Spray Tower Percent Solids Recirculated	4.4 - 7.6	5.8 - 7.8	
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	
Spray Tower Effluent Residence Time, min.	14.7	14.7	
Solids Disposal System	Clarifier & filter	Clarifier & filter	
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.21	1.03 - 1.23	
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.43 - 2.13	1.63 - 2.17	
Overall Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	90	88	
Inlet O_2 Concentration, vol. %	3.5 - 7.0	4.0 - 6.0	
Inlet SO_2 Concentration, ppm	1400 - 3400	1400 - 2700	
Overall Percent SO_2 Removal	94 - 99	95 - 98	
Average SO_2 Make-per-pass, m-mole/l	4 - 10	6.3	
Venturi Inlet pH Range	4.3 - 5.0	4.5 - 4.9	
Venturi Outlet pH Range	3.6 - 4.6	4.1 - 4.5	
Spray Tower Inlet pH Range	5.0 - 5.7	5.1 - 5.5	
Spray Tower Outlet pH Range	4.9 - 5.5	-	
Percent Sulfite Oxidation in Venturi Inlet Slurry	96.5 - 99.5	95 - 99	
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	12 - 48	29 - 51	
Air Flow Rate to Oxidizer, scfm	260	260	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.95 - 3.45	2.45	
Solids in Sludge Discharged, %	78 - 92	82 - 89	
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	105	110	
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	110	105	
Total Dissolved Solids in Venturi Inlet Liquor, ppm	11,500 - 19,200	19,230 - 21,525	
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	8800 - 14,600	13,850 - 15,260	
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	5.6 - 17.2	15.8 - 17.4	
Venturi ΔP, in. H_2O	3.5 - 9.2	9	
Mist Elimination System ΔP Range, in. H_2O	0.13 - 0.66	0.50 - 0.67	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	

Table E-2 (continued)

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIMESTONE SLURRY

Run Number	907-1B	908-1A	
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT and desupersaturation tank. Adipic acid dry fed to spray tower EHT.	Limestone slurried to 60 wt% with makeup water and added to spray tower EHT and desupersaturation tank. Adipic acid dry fed to spray tower EHT.	
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	
System Changes Before Start of Run	No changes. No cleaning	(No shutdown)	
Method of Control	Spray tower limestone stoichiometric ratio controlled at 1.7 by limestone addition to the S.T. EHT. (Override: S.T. inlet pH not less than 5.1). Venturi inlet pH controlled at 4.5 by separate limestone addition to the desupersaturation tank. Venturi recirculated slurry solids controlled at 15±1%. Clarified liquor in excess of mist eliminator wash returned to S.T. EHT and oxidation tank to control S.T. slurry solids at 6%. Adipic acid in S.T. controlled at 1500 ppm. Venturi plug position fixed to give 9 in. H_2O ΔP at 35,000 acfm gas rate. Gas rate was varied to follow a "typical" daily boiler load cycle.	Spray tower limestone stoichiometric ratio controlled at 1.7 by limestone addition to the S.T. EHT. (Override: S.T. inlet pH not less than 5.1). Venturi inlet pH controlled at 4.5 by separate limestone addition to the desupersaturation tank. Venturi recirculated slurry solids controlled at 15±1%. Clarified liquor in excess of mist eliminator wash returned to S.T. EHT and oxidation tank to control S.T. slurry solids at 6%. Adipic acid in S.T. controlled at 1500 ppm.	
Run Philosophy	The objective was to assess continuous SO_2 emissions monitoring procedures and continue to demonstrate long-term reliability of the scrubber system with respect to scaling and plugging while meeting the proposed EPA New Source Performance Standards for SO_2 emissions.	The objective was to obtain samples for Bioassay tests on limestone slurry with adipic acid additive and with forced oxidation. Adipic acid decomposition was also evaluated.	
Results	SO_2 removal averaged 97% at 2400 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The adipic acid concentration averaged 2160 ppm in the venturi and 1510 ppm in the spray tower. The filter cake solids content averaged 85%. The scrubber was not shut down at the end of the run.	SO_2 removal averaged 97% at 2050 ppm average inlet SO_2 concentration. Average sulfite oxidation was 97%. The adipic acid concentration averaged 2220 ppm in the venturi and 1495 ppm in the spray tower. The filter cake solids content averaged 86%. The mist eliminator was entirely clean at the end of the run.	

Table E-3

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH BLEED STREAM OXIDATION

Run Number	909-1A	910-1A	911-1A	912-1A
Start-of-Run Date	3/30/79	4/11/79	4/18/79	4/24/79
End-of-Run Date	4/11/79	4/16/79	4/24/79	4/26/79
On Stream Hours	239	127	134	53
Fly Ash Loading	High	High	High	High
Adipic Acid Concentration, ppm	1280 - 1680	1350 - 1650	1380 - 1780	1250 - 1750
Gas Rate, acfm @ 300°F	18,000	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	4.8	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/Mcf	42	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600	1600
Spray Tower L/G, gal/Mcf	111	57	57	57
Percent Solids Recirculated	10.4 - 13.8	14.1 - 16.5	13.9 - 16.1	13.5 - 14.5
Oxidation Tank Level, ft.	18	18	18	18
Effluent Hold Tank Residence Time, min.	11.8	11.8	11.8	11.8
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.01 - 1.11	1.02 - 1.06	1.12 - 1.23	1.05 - 1.11
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	94	96	85	93
Inlet O_2 Concentration, vol. %	3.3 - 4.5	3.5 - 6.7	3.6 - 5.2	3.7 - 4.2
Inlet SO_2 Concentration, ppm	2600 - 3050	2300 - 2800	2100 - 2700	2350 - 2950
Percent SO_2 Removal	94 - 98	92 - 98	93 - 98	94 - 98
Average SO_2 Make-Per-Pass, m-mole/l	4.7	8.2	7.7	8.6
Scrubber Inlet pH Range	5.0 - 5.6	5.0 - 5.5	5.1 - 5.5	5.1 - 5.7
Venturi Outlet pH Range	4.5 - 4.9	4.5 - 4.9	4.6 - 5.2	4.8 - 5.0
Spray Tower Outlet pH Range	-	-	-	-
Oxidation Tank pH Range	5.1 - 6.1	6.8 - 7.2	5.5 - 5.7	6.9 - 7.0
Percent Sulfite Oxidized in Scrubber Inlet Slurry	22 - 52	23 - 33	66 - 74	32 - 34
Percent Sulfite Oxidized in Oxidation Tank	91 - 99	51 - 91	98.5 - 99.5	36 - 43
Air Flow Rate to Oxidizer, scfm	120	240	240	350
Avg. Air Stoichiometric Ratio lb-atoms oxygen/lb-mole SO_2 absorbed	1.50	1.75	1.85	2.40
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Solids in Sludge Discharged, %	78 - 91	63 - 87	80 - 88	57 - 68
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	100	100	100
Calculated Avg. % Gypsum Saturation in Oxidation Tank @ 50°C	90	65	95	95
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	6530 - 8450	7675 - 8975	9150 - 9820	8910 - 9635
Total Dissolved Solids in Oxidation Tank, ppm	5845 - 6965	7080 - 7700	8635 - 9385	9125 - 9605
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	9.0 - 10.7	12.5 - 15.8	13.3 - 15.4	11.8 - 14.7
Venturi ΔP (nominal), in. H_2O	9	9	7.5	7.5
Mist Elimination System ΔP Range, in. H_2O	0.13 - 0.25	0.54 - 0.71	0.59 - 0.67	0.47 - 0.62
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-3 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH BLEED STREAM OXIDATION

Run Number	909-1A	910-1A	911-1A	912-1A
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Changed to oxidation of bleed stream. Bleed stream taken from EHT (D-101) to oxidation tank (D-108). Final bleed taken to clarifier from oxidation tank. Cleaned trap-out tray.	(No shutdown)	Repaired I.D. fan motor. Put backmix line in service.	Took backmix line out of service
Method of Control	Limestone stoichiometric ratio controlled at 1.1 with a pH underride of 5.1 at scrubber inlet. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 18,000 acfm @ 300°F.	Limestone stoichiometric ratio controlled at 1.1 with a pH underride of 5.1 at scrubber inlet. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Gas rate raised to 35,000 acfm @ 300°F and the air rate raised to 240 scfm.	Limestone stoichiometric ratio controlled at 1.1 with a pH underride of 5.1 at scrubber inlet. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Backmix rate controlled at 60 gpm.	Limestone stoichiometric ratio controlled at 1.1 with a pH underride of 5.1 at scrubber inlet. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Air rate to oxidizer increased to 350 scfm.
Run Philosophy	The purpose of this run was to determine whether high sulfite oxidation and good solids dewatering characteristics can be obtained with bleed stream oxidation of adipic acid enhanced limestone slurry.	The purpose of this run was to see if sulfite oxidation could be obtained at the maximum scrubber bleed rate (maximum gas rate and minimum bleed slurry residence time in oxidation tank).	The purpose of this run was to see if 60 gpm backmix from oxidation tank to EHT can lower the oxidation tank pH and increase the sulfite oxidation.	The purpose of this run was to see if sulfite oxidation could be obtained without backmix at 350 scfm air rate to oxidizer (cf. Run 910-1A).
Results	SO_2 removal averaged 96% at 2825 ppm average inlet SO_2 concentration. Average sulfite oxidation was 95%. The adipic acid concentration averaged 1480 ppm. The filter cake solids content averaged 85%. The scrubber was not shut down at the end of the run.	SO_2 removal averaged 95% at 2550 ppm average inlet SO_2 concentration. Average sulfite oxidation was 71%. The adipic acid concentration averaged 1500 ppm. The filter cake solids content averaged 75%. The mist eliminator was about 2% restricted at the end of the run.	SO_2 removal averaged 96% at 2400 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99%. The adipic acid concentration averaged 1580 ppm. The filter cake solids content averaged 84%.	SO_2 removal averaged 96% at 2650 ppm average inlet SO_2 concentration. Average sulfite oxidation was 40%. The adipic acid concentration averaged 1500 ppm. The filter cake solids content averaged 63%.

Table E-3 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH BLEED STREAM OXIDATION

Run Number	913-1A	
Start-of-Run Date	4/26/79	
End-of-Run Date	4/27/79	
On Stream Hours	23	
Fly Ash Loading	High	
Adipic Acid Concentration, ppm	1550 - 1715	
Gas Rate, acfm @ 300°F	18,000	
Spray Tower Gas Vel., ft/sec @ 125°F	4.8	
Venturi Liquor Rate, gpm	600	
Venturi L/G, gal/Mcf	42	
Spray Tower Liquor Rate, gpm	1600	
Spray Tower L/G, gal/Mcf	111	
Percent Solids Recirculated	13.5	
Oxidation Tank Level, ft.	18	
Effluent Hold Tank Residence Time, min.	11.8	
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.04	
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	96	
Inlet O_2 Concentration, vol. %	4.6	
Inlet SO_2 Concentration, ppm	2320 - 2400	
Percent SO_2 Removal	97 - 99	
Average SO_2 Make-Per-Pass, m-mole/l	4.0	
Scrubber Inlet pH Range	5.1 - 5.3	
Venturi Outlet pH Range	5.0	
Spray Tower Outlet pH Range	-	
Oxidation Tank pH Range	5.5	
Percent Sulfite Oxidized in Scrubber Inlet Slurry	36	
Percent Sulfite Oxidized in Oxidation Tank	95	
Air Flow Rate to Oxidizer, scfm	120	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.75	
Solids Disposal System	Clarifier & Filter	
Solids in Sludge Discharged, %	79	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	
Calculated Avg. % Gypsum Saturation in Oxidation Tank @ 50°C	95	
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	10,330	
Total Dissolved Solids in Oxidation Tank, ppm	9225	
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	8.9 - 9.1	
Venturi ΔP (nominal), in. H_2O	8	
Mist Elimination System ΔP Range, in H_2O	0.16 - 0.18	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.	

Table E-3 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH BLEED STREAM OXIDATION

Run Number	913-1A	
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air upward through an open elbow 9 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	
System Changes Before Start of Run	(No shutdown)	
Method of Control	Scrubber inlet slurry pH controlled at 5.0 with a 4.9 override. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 18,000 acfm @ 300°F. Air rate to oxidizer controlled at 120 scfm.	
Run Philosophy	The purpose of this run was to obtain slurry conditions necessary for Radian Corp. to complete their adipic acid material balance around the oxidation tank.	
Results	SO_2 removal averaged 98% at 2360 ppm average inlet SO_2 concentration. Average sulfite oxidation was 95%. The adipic acid concentration averaged 1630 ppm. The filter cake solids content averaged 79%.	

Table E-3 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH BLEED STREAM OXIDATION

Run Number	915-1A	915-1B	915-1C
Start-of-Run Date	4-10-80	4/14/80	4/15/80
End-of-Run Date	4-14-80	4/15/80	4/21/80
Onstream Hours	98	24	127
Fly Ash Loading	High	High	High
Adipic Acid Concentration, ppm	3540-4140	3890-4200	3940-4350
Gas Rate, acfm @ 300°F	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/mcf	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600
Spray Tower L/G, gal/mcf	57	57	57
Percent Solids Recirculated	14.4-16.0	15.2-15.8	14.9-15.3
Oxidation Tank Level, ft.	17	17	17
Effluent Hold Tank Residence Time, min.	9.1	9.1	9.1
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.04-1.16	1.09-1.14	1.10-1.18
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	91	90	88
Inlet O_2 Concentration, vol. %	3.7-4.8	3.6-4.3	4.2-5.0
Inlet SO_2 Concentration, ppm	2120-2560	2100-3000	1900-2160
Overall Percent SO_2 Removal	97-98	97-99	95-97
Average SO_2 Make-per-pass, m-mole/l	7.7	8.4	6.6
Scrubber Inlet pH Range	4.9-5.1	5.0-5.2	4.7-4.9
Scrubber Outlet pH	4.6-4.8	4.8	4.6-4.7
Oxidation Tank pH Range	5.2-5.6	5.4-6.0	4.7-4.9
Percent Sulfite Oxidized in Scrubber Inlet Slurry	15-36	23-28	50-58
Percent Sulfite Oxidized in Oxidation Tank	63-75	70-77	97-99
Air Flow Rate to Oxidizer, scfm	200	300	200
Average Air Stoichiometry Ratio atoms O/mole SO_2, abs.	1.55	2.10	1.80
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	67-72	79-80	78-80
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	105	100
Calculated Avg. % Gypsum Saturation in Oxidation Tank @ 50°C	105	105	100
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	16800-18610	16110-16900	19685-19915
Total Dissolved Solids in Oxidation Tank, ppm	16590-17780	15980-17220	18650-18855
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	15.5-16.3	16.2-16.8	15.6-16.5
Venturi ΔP	8.6-9.6	8.6-9.1	8.7-9.5
Mist Elimination System ΔP Range, in. H_2O	0.29-0.34	0.30-0.33	0.32-0.36
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-3 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH BLEED STREAM OXIDATION

Run Number	915-1A	915-1B	915-1C
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316L SS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316L SS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Changed to oxidation of bleed stream. Bleed stream taken from EHT (D-101) to oxidation tank (D-208). Final bleed taken to clarifier from oxidation tank.	(No shutdown)	(No shutdown)
Method of Control	Scrubber inlet slurry-pH controlled at 5.1. Adipic acid concentration is controlled at 4000 ppm. Slurry solids controlled at 15% ± 1%. Gas rate controlled at 35,000 acfm @ 300°F. Air rate to oxidizer controlled at 200 scfm.	Scrubber inlet slurry-pH controlled at 5.1. Adipic acid concentration is controlled at 4000 ppm. Slurry solids controlled at 15% ± 1%. Gas rate controlled at 35,000 acfm @ 300°F. Air rate to oxidizer controlled at 300 scfm.	Scrubber inlet slurry pH controlled at 4.8. Adipic acid concentration is controlled at 4000 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 35,000 acfm @ 300°F. Air rate to oxidizer controlled at 200 scfm.
Run Philosophy	The purpose of this run was to determine whether high sulfite oxidation and good solids dewatering characteristics can be obtained with bleed stream oxidation of adipic acid enhanced limestone slurry.	The purpose of this run was to see if increased air would significantly improve the oxidation of sulfite solids.	The purpose of this run was to see if reducing the pH of the scrubber liquor would allow higher oxidation of the sulfite solids in the bleed stream.
Results	SO_2 removal averaged 97.6% at 2340 ppm average inlet SO_2 concentration. Average sulfite oxidation was 69%. The adipic acid concentration averaged 3840 ppm. The centrifuge cake solids content averaged 70%.	SO_2 removal averaged 98% at 2550 ppm average inlet SO_2 concentration. Average sulfite oxidation was 73%. The adipic acid concentration averaged 4045 ppm. The centrifuge cake solids content averaged 79%.	SO_2 removal averaged 96% at 2030 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98%. The adipic acid concentration averaged 4140 ppm. The centrifuge cake solids content averaged 79%.

Table E-4

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	914-1A
Start-of-Run Date	3-13-80
End-of-Run Date	3-19-80
Onstream Hours	105
Fly Ash Loading	High
Adipic Acid Concentration, ppm	3325-4750
Gas Rate, acfm @ 300°F	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4
Venturi Liquor Rate, gpm	600
Venturi L/G, gal/mcf	21
Spray Tower Liquor Rate, gpm	1600
Spray Tower L/G, gal/mcf	57
Percent Solids Recirculated	14.7-17.1
Oxidation Tank Residence Time, min.	2.9
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.60-2.72
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	46
Inlet O_2 Concentration, vol. %	3.6-4.7
Inlet SO_2 Concentration, ppm	1760-2200
Overall Percent SO_2 Removal	86-97
Average SO_2 Make-per-pass, m-mole/l	6.1
Scrubber Inlet pH Range	4.4-4.9
Scrubber Outlet pH Range	4.2-4.6
Percent Sulfite Oxidized in Scrubber Inlet Slurry	98.3-99.1
Solids Disposal System	Clarifier & Centrifuge
Solids in Sludge Discharged, %	78-80
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	143
Scrubber Liquor Fe Concentration, ppm	21.7
Scrubber Liquor Mn Concentration, ppm	18.2
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	17440-21080
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	14.6-17.3
Venturi ΔP	9
Mist Elimination System ΔP Range, in H_2O	0.28-0.36
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-4 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	914-1A
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Tank D-208 was converted to Oxidation Tank.
Method of Control	The inlet pH is controlled at 4.6 by limestone addition to EHT/Oxidation Tank D-208. Adipic acid concentration is controlled at 4000 ppm. Recirculated slurry solids controlled at 15% ± 1%. Air stoichiometry controlled at 1.9 atom O/mole SO_2 abs.
Run Philosophy	This run was the first of a series originally planned to investigate the effects of adipic acid concentration and liquor pH on the SO_2 removal and adipic acid consumption rate with forced oxidation.
Results	SO_2 removal averaged 91.6% at 1980 ppm inlet SO_2 concentration and 4040 ppm adipic acid concentration. The adipic acid consumption ratio (Actual/Theor.) was 2.92. Sulfite oxidation was 98.7%. Limestone utilization was 46%, indicating severe limestone blinding. Centrifuge cake was 79% by wt. solids.

Table E-4 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	914-1C
Start-of-Run Date	4-7-80
End-of-Run Date	4-9-80
Onstream Hours	47
Fly Ash Loading	High
Adipic Acid Concentration, ppm	3600-4850
Gas Rate, acfm @ 300°F	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4
Venturi Liquor Rate, gpm	600
Venturi L/G, gal/mcf	21
Spray Tower Liquor Rate, gpm	1600
Spray Tower L/G, gal/mcf	57
Percent Solids Recirculated	13.9-15.9
Oxidation Tank Residence Time, min.	2.9
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.04-1.10
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	93
Inlet O_2 Concentration, vol. %	3.3-4.3
Inlet SO_2 Concentration, ppm	1550-2360
Overall Percent SO_2 Removal	89-96
Average SO_2 Make-per-pass, m-mole/l	6.1
Scrubber Inlet pH Range	4.5-4.8
Scrubber Outlet pH Range	4.3-4.6
Percent Sulfite Oxidized in Scrubber Inlet Slurry	24-41
Solids Disposal System	Clarifier & Centrifuge
Solids in Sludge Discharged, %	62-68
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	120
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	20470-23005
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	15.2-16.2
Venturi ΔP Range, in. H_2O	8.6-9.7
Mist Elimination System P Range, in. H_2O	0.30-0.34
Venturi ΔP	8.6-9.7
Mist Elimination System ΔP Range, in H_2O	.30-.34
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-4 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	914-1C
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Spray tower turned on. No shutdown.
Method of Control	The inlet pH is controlleld at 4.6 by limestone addition to EHT/Oxidation Tank D-208. Adipic acid concentration is controlled at 4000 ppm. Recirculated slurry solids controlled at 15% ± 1%.
Run Philosophy	The purpose of this run was to carry out a baseline test using D-208 without forced oxidation to observe SO_2 removal, limestone utilization and adipic acid consumption.
Results	SO_2 removal averaged 92.6% at 1955 ppm inlet SO_2 concentration and 4225 ppm adipic acid concentration. The adipic acid consumption ratio (Actual/Theor.) was 1.36. Sulfite oxidation was 32%. Limestone utilization was 93%, indicating severe limestone blinding. Centrifuge cake was 65% by wt. solids.

Table E-5

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH TWO TANKS AND FORCED OXIDATION

Run Number	916-1A	916-1B
Start-of-Run Date	4-24-80	4-28-80
End-of-Run Date	4-28-80	5-1-80
Onstream Hours	89	77
Fly Ash Loading	High	High
Adipic Acid Concentration, ppm	3600-4380	3600-4430
Gas Rate, acfm @ 300°F	35,000	30,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	8.1
Venturi Liquor Rate, gpm	600	600
Venturi L/G, gal/mcf	21	25
Spray Tower Liquor Rate, gpm	500	1200
Spray Tower L/G, gal/mcf	18	50
Percent Solids Recirculated	15.2-16.2	14.3-16.4
Effluent Hold Tank Residence Time, min.	18.2	11.1
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.08-1.79	1.05-1.33
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	70	84
Inlet O_2 Concentration, vol. %	3.7-5.1	3.7-4.5
Inlet SO_2 Concentration, ppm	1680-2340	1940-2400
Overall Percent SO_2 Removal	84-92	96-97
Average SO_2 Make-per-pass, m-mole/l	12.0	7.4
Scrubber Inlet pH Range	4.6-4.9	4.7-5.0
Scrubber Outlet pH Range	4.4-4.6	4.4-4.7
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99-100	99-100
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	78-79	74-78
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	120	105
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	15390-19580	17285-18430
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	14.9-16.3	10.2-10.8
Venturi ΔP	8.7-9.9	5.2-6.2
Mist Elimination System ΔP Range, in H_2O	0.28-0.35	0.20-0.27
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-5 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH TWO TANKS AND FORCED OXIDATION

Run Number	916-1A	916-1B
Oxidizer Design	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Changed to 2-tank oxidation. A new 16" ø overflow line from the oxidation tank, D-208, to the EHT, D-101, was installed. Bleed taken from the effluent hold tank.	(No shutdown)
Method of Control	Scrubber inlet slurry pH controlled at 4.8. Adipic acid concentration controlled at 4000 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 35,000 acfm @ 300°F. Liquor to the spray tower was held at 500 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 1.5 atoms O/mole SO_2 absorbed.	Scrubber inlet slurry pH controlled at 4.8. Adipic acid concentration controlled at 4000 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 30,000 acfm @ 300°F. Liquor to the spray tower increased to 1200 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 1.5 atoms O/mole SO_2 absorbed.
Run Philosophy	The purpose of this run was to monitor SO_2 removal, limestone utilization and adipic acid consumption in a 2-tank operating mode while operating at reduced pH and low L/G.	The purpose of this run was to monitor the SO_2 removal in a 2-tank system at reduced pH and more conventional L/G.
Results	SO_2 removal averaged 88% at 2010 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.4%. The adipic acid concentration averaged 3990 ppm. The centrifuge cake solids content averaged 79%.	SO_2 removal averaged 96.5% at 2170 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.7%. The adipic acid concentration averaged 4015 ppm. The centrifuge cake solids content averaged 76%.

Table E-5 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH TWO TANKS AND FORCED OXIDATION

Run Number	916-1C	916-1D	916-1E
Start-of-Run Date	5-2-80	5-6-80	5-13-80
End-of-Run Date	5-6-80	5-13-80	5-19-80
Onstream Hours	92	163	145
Fly Ash Loading	High	High	High
Adipic Acid Concentration, ppm	3430 → 1600 (Depletion)	1350-1630	1400-1680
Gas Rate, acfm @ 300°F	30,000	30,000	20,000
Spray Tower Gas Vel., ft/sec @ 125°F	8.1	8.1	5.4
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/mcf	25	25	38
Spray Tower Liquor Rate, gpm	1200	1200	1600
Spray Tower L/G, gal/mcf	50	50	100
Percent Solids Recirculated	13.5-16.7	14.4-15.6	13.5-16.8
Effluent Hold Tank Residence Time, min.	11.1	11.1	11.1
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.06-1.22	1.1-1.7	1.05-1.27
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	88	72	86
Inlet O_2 Concentration, vol. %	3.7-4.7	3.6-4.6	4.2-5.6
Inlet SO_2 Concentration, ppm	2020-2640	1870-2560	1510-2240
Overall Percent SO_2 Removal	93.7 → 91.2 (ave)	89-96	97-99
Average SO_2 Make-per-pass, m-mole/l	7.5 → 7.7	7.3	3.6
Scrubber Inlet pH Range	4.7-5.0	4.9-5.3	5.0-5.3
Scrubber Outlet pH Range	4.4-4.9	4.7-4.9	4.7-5.1
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99.3-100.0	99.5-100.0	99-100
Avg. Air Flow Rate to Oxidizer, scfm	160-156	151	90
Air Stiochiometric Ratio, atoms O/mole SO_2 absorbed	1.5	1.5	1.5
Solids Disposal System	Clarifier Only	Clarifier & Centrifuge/Filter	Clarifier & Filter
Solids in Sludge Discharged, %	26-42	80-88	87-90
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	105	105
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	12070-16190	12250-14540	13780-16250
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	11.4-13.2	10.9-11.6	9.8-10.2
Venturi ΔP, in. H_2O	6.4-7.0	5.1-6.8	7.3-7.8
Mist Elimination System ΔP Range, in H_2O	0.27-0.31	0.23-0.38	0.15-0.18
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-5 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH TWO TANKS AND FORCED OXIDATION

Run Number	916-1C	916-1D	916-1E
Oxidizer Design	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No Changes No Shutdown	No Changes	No Changes No Shutdown
Method of Control	Scrubber inlet slurry pH controlled at 4.8. Adipic acid concentration depleted from 4000 ppm to 1500 ppm Slurry solids controlled at 15 ± 1%. Gas rate controlled at 30,000 acfm @ 300°F. Liquor to the spray tower was held at 1200 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 1.5 atoms O/mole SO_2 absorbed.	Scrubber inlet slurry pH controlled at 5.1. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 30,000 acfm @ 300°F. Liquor to the spray tower 1200 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 1.5 atoms O/mole SO_2 absorbed.	Scrubber inlet slurry pH controlled at 5.1. Adipic acid concentration depleted from 1500 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 20,000 acfm @ 300°F. Liquor to the spray tower was held at 1600 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 1.5 atoms O/mole SO_2 absorbed.
Run Philosophy	The purpose of this run was to monitor SO_2 removal, while operating at reduced pH and a depleting concentration of apidic acid.	The purpose of this run was to monitor SO_2 removal in a 2-tank system at increased pH and reduced concentration at adipic acid.	The purpose of this run was to monitor SO_2 removal and limestone utilization while operating at high L/G and reduced make-per-pass.
Results	SO_2 removal averaged 93.7 → 91.2% at 2330 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.7%. The adipic acid concentration depleted from 3450 to 1600 ppm. The clarifier underflow solids content averaged 34%.	SO_2 removal averaged 92.4% at 2220 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.8%. The adipic acid concentration averaged 1490 ppm. The filter cake solids content averaged 84%.	SO_2 removal averaged 98% at 1880 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.5%. The adipic acid concentration averaged 1540 ppm. The filter cake solids content averaged 88%.

Table E-5 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH TWO TANKS AND FORCED OXIDATION

Run Number	916-1F	916-1G	916-1H
Start-of-Run Date	5-19-80	5-22-80	5-25-80
End-of-Run Date	5-22-80	5-24-80	5-28-80
Onstream Hours	71	61	84
Fly Ash Loading	High	High	High
Adipic Acid Concentration, ppm	1450-1570	1430-1670	1190-1690
Gas Rate, acfm @ 300°F	30,000	30,000	30,000
Spray Tower Gas Vel., ft/sec @ 125°F	8.1	8.1	8.1
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/mcf	25	25	25
Spray Tower Liquor Rate, gpm	1200	1200	1200
Spray Tower L/G, gal/mcf	50	50	50
Percent Solids Recirculated	15.3-16.4	14.1-17.0	14.7-16.5
Effluent Hold Tank Residence Time, min.	11.1	11.1	11.1
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.8-2.5	1.55-1.70	1.04-1.05
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	46	61	96
Inlet O_2 Concentration, vol. %	3.8-4.6	4.0-4.5	3.8-4.6
Inlet SO_2 Concentration, ppm	2090-2440	1960-2340	2400-2600
Overall Percent SO_2 Removal	86-92	92-95	81-90
Average SO_2 Make-per-pass, m-mole/l	7.1	7.1	7.6
Scrubber Inlet pH Range	5.0-5.3	5.3-5.4	4.9-5.3
Scrubber Outlet pH Range	4.6-5.0	5.3-5.4	4.6-4.8
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99-100	99-100	45-55
Avg. Air Flow Rate to Oxidizer, scfm	149	246	none
Air Stiochiometric Ratio, atoms O/mole SO_2 absorbed	1.5	2.5	0
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Solids in Sludge Discharged, %	83-85	82-88	58-60
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	145	115	120
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	16660-17630	15680-16530	14730-16420
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	10.7-11.1	10.6-11.0	9.7-10.2
Venturi ΔP, in. H_2O	6.1-6.5	6.0-6.2	5.9-6.3
Mist Elimination System ΔP Range, in H_2O	0.28-0.32	0.29-0.31	0.29-0.32
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-5 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS WITH TWO TANKS AND FORCED OXIDATION

Run Number	916-1F	916-1G	916-1H
Oxidizer Design	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316LSS pipe which extends to near the center of the oxidation tank 12 inches above the lower turbine and discharges air upward through an open elbow 47 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 17 ft.	None used
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No Changes No shutdown	No Changes No shutdown	No Changes No shutdown
Method of Control	Scrubber inlet slurry pH controlled at 5.4. Adipic acid concentration depleted from 1500 ppm Slurry solids controlled at 15 ± 1%. Gas rate controlled at 30,000 acfm @ 300°F. Liquor to the spray tower was held at 1200 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 1.5 atoms O/mole SO_2 absorbed.	Scrubber inlet slurry pH controlled at 4.8. Adipic acid concentration controlled at 1500 ppm. Slurry solids controlled at 15 ± 1%. Gas rate controlled at 30,000 acfm @ 300°F. Liquor to the spray tower 1200 gpm. Air rate to oxidizer controlled to give an air stoichiometry of 2.5 atoms O/mole SO_2 absorbed.	Scrubber inlet slurry pH controlled at 5.0. Adipic acid concentration depleted from 1500 ppm Slurry solids controlled at 15 ± 1%. Gas rate controlled at 30,000 acfm @ 300°F. Liquor to the spray tower 1200 gpm.
Run Philosophy	The purpose of this run was to monitor SO_2 removal, limestone utilization and adipic acid consumption in a 2-tank operating mode while operating at high pH.	The purpose of this run was to monitor the limestone utilization at high pH and high air stoichiometry.	The purpose of this run was to monitor SO_2 removal in a 2-tank system normal pH and more conventional L/B without forced oxidation.
Results	SO_2 removal averaged 89.2 at 2260 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.4%. The adipic acid concentration averaged 1510 ppm. The filter cake solids content averaged 84%.	SO_2 removal averaged 93.7% at 2150 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99.6%. The adipic acid concentration averaged 1550 ppm. The filter cake solids content averaged 85%.	SO_2 removal averaged 85.5 at 2500 ppm average inlet SO_2 concentration. Average sulfite oxidation was 50.4%. The adipic acid concentration averaged 1440 ppm. The filter cake solids content averaged 59%.

Table E-6

SUMMARY OF SPRAY TOWER LIMESTONE RELIABILITY TEST WITH TWO-TANK FORCED OXIDATION AND ADIPIC ACID ADDITION

Run Number	917-1A
Start-of-Run Date	12/26/80
End-of-Run Date	3/13/81
Onstream Hours	1688
Fly Ash Loading	High
Adipic Acid Concentration, beginning 2/6/81, ppm	1640-1850
Adipic Acid Concentration, before 2/6/81, ppm	1165-1445
Gas Rate, acfm @ 300°F	20,000-35,000
Liquor Rate, gpm	2400
Scrubber L/G, gal/mcf	85-150
Percent Solids Recirculated	14.3-16.2
Oxidation Tank, Level, ft	18
Oxidation Tank Residence Time, min	2.8
Effluent Hold Tank Level, ft	8.5
Effluent Hold Tank Residence Time, min	8.3
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.03-1.25
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	93
Inlet O_2 Concentration, vol. %	4.5 - 8.6
Inlet SO_2 Concentration, ppm	2260-3180
Percent SO_2 Removal	87-99
Average SO_2 Make-per-Pass, m-mole/l	7.0
Scrubber Inlet Liquor pH	4.9-5.2
Scrubber Outlet Liquor pH	4.3-4.9
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99.1-100
Solids Disposal System	Clarifier and Drum or Belt Filter
Solids in Cake Discharged, wt%	82-88
Ave. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	93
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	9860-15,540
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	1.5-3.0
Mist Elimination System ΔP Range, in. H_2O	0.05-0.28
Scrubber Inlet Liquor $SO_3^=$ Conc; ppm	36
Scrubber Outlet Liquor $SO_3^=$ Conc; ppm	440
Scrubber Inlet Liquor Fe Conc; ppm	.10
Scrubber Inlet Liquor Mn Conc; ppm	33

Table E-6 (continued)

SUMMARY OF SPRAY TOWER LIMESTONE RELIABILITY TEST WITH TWO-TANK FORCED OXIDATION AND ADIPIC ACID ADDITION

Run Number	917-1A
Mist Elimination System Configuration	Three-pass, open-vanes, 316LSS chevron mist eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq. ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry-fed to EHT.
Scrubber Internals	Four spray headers. Top 3 headers spraying downward, bottom header spraying upward. Twelve Bete ST48FCN nozzles on each header.
System Changes Before Start of Run	No changes. Cleaned the presaturator section, reheater and I.D. fan damper.
Method of Control	Scrubber inlet pH controlled at 5.0 - 0.1 (changed to 5.1 $^{+}$ 0.1 on 1/30/81). Recirculated slurry concentration controlled at 15 $^{+}$ 1%. Adipic acid concentration controlled at 1300 ppm - 10% before 2/6/81 and 1700 ppm - 10% beginning 2/6/81. EHT and oxidation tank levels controlled at 8.5ft and 18 ft, respectively.
Run Philosophy	This was long-term reliability test. The objectives were to obtain 90% or higher SO_2 removal at typical boiler load cycle and to demonstrate scale- and plugging-free operation.
Results	SO_2 removal averaged 93% at 2660 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 1520 ppm in the scrubber inlet liquor. No scaling or plugging of scrubber internals other than some plugged slurry nozzles.

Table E-7

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Run Number	926-1A	926-1G	926-1B	926-1C
Start-of-Run Date	12-18-79	1-03-80	1-16-80	1-24-80
End-of-Run Date	1-3-80	1-16-80	1-24-80	1-29-80
On Stream Hours	297	244	184	116
Fly Ash	High	High	High	High
Adipic Acid Concentration, ppm	3775-4400	1950-2650	1220-1720	1130-1540
Gas Rate, acfm @ 300°F	35,000	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600	600
Venturi L/G, gal/mcf	21	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600	1600
Spray Tower L/G, gal/mcf	57	57	57	57
Percent Solids Recirculated	14.9-16.1	13.3-16.9	13.4-16.4	14.2-16.0
Effluent Hold Tank Residence Time, min.	9.1	9.1	9.1	9.1
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.02-1.03	1.02-1.06	1.03-1.07	1.02-1.09
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	97	96	95	95
Inlet O_2 Concentration, vol. %	3.0-5.3	3.0-7.2	3.3-6.5	3.6-5.1
Inlet SO_2 Concentration, ppm	2300-3000	1640-2860	1800-2430	1720-2580
Overall Percent SO_2 Removal	54-95	85-96	75-93	85-97
Average SO_2 Make-per-pass, m-mole/l	8.0	6.9	6.0	6.6
Scrubber Inlet pH Range	4.4-4.7	4.6-5.1	4.6-5.1	4.8-5.2
Scrubber Outlet pH Range	-	4.4-4.6	4.3-4.8	4.5-4.8
Percent Sulfite Oxidized in Scrubber Inlet Slurry	43-55	45-57	29-59	29-65
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	67-71	65-75	67-73	64-72
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	130	116	127	129
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	17390-18830	14630-16430	12990-17010	13480-16090
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	14.7-15.3	14.3-15.5	15.3-16.3	15.1-16.5
Venturi ΔP	9	9	9	9
Mist Elimination System P Range, in H_2O	.25-.31	.24-.36	.27-.34	.28-.33
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-7 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Run Number	926-1A	926-1G	926-1B	926-1C
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No changes. No shutdown.	No changes. No shutdown.	No changes. No shutdown.	No changes. No shutdown.
Method of Control	The inlet pH is controlled at 4.6 by limestone addition to EHT (D-101). Adipic acid concentration is controlled to achieve 92% SO_2 removal. Recirculated slurry solids controlled at 15% ± 1%.	The inlet pH is controlled at 4.8 by limestone addition to EHT (D-101). Adipic acid concentration is controlled to achieve 92% SO_2 removal. Recirculated slurry solids controlled at 15% ± 1%.	The inlet pH is controlled at 4.8 by limestone addition to EHT (D-101). Adipic acid concentration is controlled at 1300 ppm. Recirculated slurry solids controlled at 15% ± 1%.	The inlet pH is controlled at 5.0 by limestone addition to EHT (D-101). Adipic acid concentration is controlled at 1300 ppm. Recirculated slurry solids controlled at 15% ± 1%.
Run Philosophy	This run was the initial run of an adipic acid optimization series. The purpose of this run was to determine adipic acid degradation at low pH and high (90+%) SO_2 removal and without forced oxidation.	This run at somewhat higher pH than 926-1A was added to the initial series to obtain better process control and higher SO_2 removal.	This run was made to determine adipic acid degradation and SO_2 removal at a pH of 4.8 and 1300 ppm adipic acid concentration.	This run was made to determine adipic acid degradation and SO_2 removal at a pH of 5.0 and 1300 ppm adipic acid concentration.
Results	SO_2 removal averaged 90% at 2650 ppm inlet SO_2 concentration and 4090 ppm adipic acid concentration. The adipic acid consumption was equal to the theoretically required amount. Sulfite oxidation was 49%. Limestone utilization was 97%. Centrifuge cake was 69% by wt. solids.	SO_2 removal averaged 91% at 2250 ppm inlet SO_2 concentration and 2270 ppm adipic acid concentration. The adipic acid consumption was equal to the theoretically required amount. Sulfite oxidation was 51%. Limestone utilization was 96%. Centrifuge cake was 70% by wt. solids.	SO_2 removal averaged 84% at 2115 ppm inlet SO_2 concentration and 1435 ppm adipic acid concentration. The adipic acid consumption was equal to the theoretically required amount. Sulfite oxidation was 49%. Limestone utilization was 95%. Centrifuge cake was 69% by wt. solids.	SO_2 removal averaged 91% at 2150 ppm inlet SO_2 concentration and 1290 ppm adipic acid concentration. The adipic acid consumption was equal to the theoretically required amount. Sulfite oxidation was 47%. Limestone utilization was 95%. Centrifuge cake was 66% by wt. solids.

Table E-7 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Run Number	926-1H	926-1D	926-1E
Start-of-Run Date	1-29-80	2-08-80	2-15-80
End-of-Run Date	2-5-80	2-13-80	2-20-80
Onstream Hours	169	116	119
Fly Ash Loading	High	High	High
Adipic Acid Concentration, ppm	1070-1550	1050-1600	515-915
Gas Rate, acfm @ 300°F	35,000	35,000	35,000
Spray Tower Gas Vel., ft/sec @ 125°F	9.4	9.4	9.4
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/mcf	21	21	21
Spray Tower Liquor Rate, gpm	1600	1600	1600
Spray Tower L/G, gal/mcf	57	57	57
Percent Solids Recirculated	13.7-16.1	14.6-16.4	14.0-16.4
Effluent Hold Tank Residence Time, min.	9.1	9.1	9.1
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.06-1.11	1.14-1.36	1.04-1.06
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	92	80	95
Inlet O_2 Concentration, vol. %	3.7-4.7	3.6-4.8	3.4-4.6
Inlet SO_2 Concentration, ppm	1880-2420	2140-2680	2020-2880
Overall Percent SO_2 Removal	90-96	96-97	69-85
Average SO_2 Make-per-pass, m-mole/l	6.8	7.9	6.4
Scrubber Inlet pH Range	5.0-5.5	5.4-5.6	4.9-5.2
Scrubber Outlet pH Range	4.6-5.1	4.9-5.1	4.5-4.7
Percent Sulfite Oxidized in Scrubber Inlet Slurry	22-38	15-23	16-48
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	56-70	54-68	55-65
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	118	112	113
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	13580-16070	13440-16480	10600-14010
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	14.4-17.0	15.2-16.2	14.9-17.1
Venturi ΔP	9	9	9
Mist Elimination System ΔP Range, in H_2O	.26-.30	.25-.32	.26-.32
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-7 (continued)

SUMMARY OF VENTURI/SPRAY TOWER LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Run Number	926-1H	926-1D	926-1E
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	No changes. No shutdown.	No changes. No shutdown.	No changes. No shutdown.
Method of Control	The inlet pH is controlled at 5.25 by limestone addition to EHT (D-101). Adipic acid concentration is controlled at at 1300 ppm. Recirculated slurry solids controlled at 15% ± 1%.	The inlet pH is controlled at 5.5 by limestone addition to EHT (D-101). Adipic acid concentration is controlled at 1300 ppm. Recirculated slurry solids controlled at 15% ± 1%.	The inlet pH is controlled at 5.0 by limestone addition to EHT (D-101). Adipic acid concentration is controlled at 700 ppm. Recirculated slurry solids controlled at 15% + 1%.
Run Philosophy	This run was added to the original test program to obtain more information on adipic acid degradation and SO_2 removal in the 5.0 to 5.5 pH range.	This run was made to determine adipic acid degradation and SO_2 removal at a pH of 5.5 and 1300 pm adipic acid concentration.	This run was made to determine adipic acid degradation and SO_2 removal at a pH of 5.0 and 700 ppm adipic acid concentration.
Results	SO_2 removal averaged 93% at 2150 ppm inlet SO_2 concentration and 1285 ppm adipic acid concentration. The adipic acid consumption was 1.06 times the theoretically required amount. Sulfite oxidation was 30%. Limestone utilization was 92%. Centrifuge cake was 61% by wt. solids.	SO_2 removal averaged 96% at 2410 ppm inlet SO_2 concentration and 1330 ppm adipic acid concentration. The adipic acid consumption was 1.36 times the theoretically required amount. Sulfite oxidation was 17%. Limestone utilization was 80%. Centrifuge cake was 60% by wt. solids.	SO_2 removal averaged 77% at 2450 ppm inlet SO_2 concentration and 715 ppm adipic acid concentration. The adipic acid consumption was equal to the theoretically required amount. Sulfite oxidation was 32%. Limestone utilization was 95%. Centrifuge cake was 60% by wt. solids.

Table E-8

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Run Number	927-1A	927-1B	927-1J	927-1C	927-1D	927-1E
Start-of-Run Date	2-20-80	2-22-80	2-22-80	2-24-80	2-26-80	2-27-80
End-of-Run Date	2-22-80	2-24-80	2-23-80	2-26-80	2-27-80	3-01-80
Onstream Hours	43	24	24	48	27	69
Fly Ash Loading	High	High	High	High	High	High
Adipic Acid Concentration, ppm	750-880	660-750	740-850	1230-1490	1230-1440	3750-4220
Gas Rate, acfm @ 300°F	35,000	20,000	27,500	20,000	35,000	35,000
Venturi Liquor Rate, gpm	600	600	600	600	600	600
Venturi L/G, gal/mcf	21	37	27	37	21	21
Percent Solids Recirculated	13.6-15.6	14.3-14.7	14.6	13.8-14.3	15.7-16.9	14.9-15.8
Effluent Hold Tank Residence Time, min.	33.4	33.4	33.4	33.4	33.4	33.4
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.07-1.11	1.08-1.09	1.09	1.08-1.11	1.14-1.27	1.15-1.19
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	92	92	91	91	83	85
Inlet O_2 Concentration, vol. %	4.2-5.6	3.6-4.2	3.8	3.7-4.0	3.5-3.7	4.0-4.3
Inlet SO_2 Concentration, ppm	1800-2180	2360-2580	2140-2640	2440-2750	2370-2520	2280-2440
Overall Percent SO_2 Removal	84-95	85-96	31-35	43-51	38-44	64-66
Average SO_2 Make-per-pass, m-mole/l	8.4	6.8	7.7	8.6	8.4	8.3
Scrubber Inlet pH Range	4.8-5.2	5.0-5.3	5.0-5.2	5.0-5.3	5.0-5.3	5.0-5.2
Scrubber Outlet pH Range	4.6-4.9	4.6-4.8	4.6	4.5-4.6	4.6-4.9	4.6-4.7
Percent Sulfite Oxidized in Scrubber Inlet Slurry	31-41	30-38	29	27-37	30-34	20-36
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	63-67	67	68	65-68	67-70	59-63
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	99	115	138	123	118	131
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	11620-12780	13470	12740-13250	12620-13480	15130-15680	10610-14010
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	13.9-14.8	7.5-7.9	9.2-9.4	7.8-8.4	14.3-14.6	13.7-14.9
Venturi ΔP	8.2	5.9	5.9	6.0	8.4	8.3
Mist Elimination System ΔP Range, in H_2O	.28-.32	.10-.11	.17-.18	.05-.10	.24-.26	.23-.27
Scrubber Inlet $SO_3^=$ Concentration, ppm	364	366	109	330	253	285
Scrubber Outlet $SO_3^=$ Concentration, ppm	821	860	534	849	496	515
Scrubber Liquor Fe Concentration, ppm	20	12	10	8	1	9
Scrubber Liquor Mn Concentration, ppm	8	9	8	9	10	7

Table E-8 (continued)

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Run Number	927-1F	927-1G	927-1H	927-1I	927-1K	927-1L
Start-of-Run Date	3-1-80	3-1-80	3-2-80	3-2-80	3-4-80	3-5-80
End-of-Run Date	3-1-80	3-2-80	3-2-80	3-3-80	3-5-80	3-6-80
Onstream Hours	26	13	13	21	32	16
Fly Ash Loading	High	High	High	High	High	High
Adipic Acid Concentration, ppm	3860-4120	3975-4085	3950-4060	3805-4230	3920-4175	4290-4385
Gas Rate, acfm @ 300°F	27,500	20,000	27,500	27,500	27,500	20,000
Venturi Liquor Rate, gpm	600	600	600	600	600	600
Venturi L/G, gal/mcf	27	37	27	27	27	37
Percent Solids Recirculated	15.3	14.3	15.0	15.0-15.6	14.3-15.2	13.0-14.1
Effluent Hold Tank Residence Time, min.	33.4	33.4	33.4	33.4	33.4	33.4
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.17	1.17	1.14	1.08-1.11	1.06-1.09	1.07-1.14
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	85	85	88	91	93	90
Inlet O_2 Concentration, vol. %	4.2	4.1	3.8	3.9-4.1	4.3-4.8	4.4-4.6
Inlet SO_2 Concentration, ppm	2200-2310	2580-3000	2920-3140	2800-3090	2160-2320	2000-2200
Overall Percent SO_2 Removal	65-68	66-69	69-70	62-68	56-62	61-63
Average SO_2 Make-per-pass, m-mole/l	14.7	13.4	20.3	18.6	12.9	9.2
Scrubber Inlet pH Range	5.0-5.2	5.0-5.2	5.0-5.2	5.0-5.2	4.7-5.0	4.75-4.85
Scrubber Outlet pH	4.6	4.5	4.7	4.5	4.2-4.4	4.4-4.5
Percent Sulfite Oxidized in Scrubber Inlet Slurry	23	22	20	27-38	18-35	25-36
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	63	63	63	62-63	63-67	66-69
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	130	145	125	120	140	125
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	17450	17495	17375	16670-17645	18165-18440	17760-18005
Total P Range, Excluding Mist Elimination System, in. H_2O	9.8-10.0	7.9-8.3	12.2-12.8	14.6-15.2	12.1-12.6	8.2-8.6
Venturi P	5.8-6.0	5.9-6.1	8.6-8.9	11.0-11.2	8.6-8.9	6.0-6.4
Mist Elimination System P Range, in. H_2O	0.13-0.15	0.05-0.07	0.15-0.17	0.15-0.18	0.17-0.19	0.07-0.09
Scrubber Inlet $SO_3^=$ Concentration, ppm	461	235	485	449	907	1113
Scrubber Outlet $SO_3^=$ Concentration, ppm	878	838	1227	1163	1456	1809
Scrubber Liquor Fe Concentration, ppm	11	--	11	3	45	49
Scrubber Liquor Mn Concentration, ppm	7	7	--	7	10	10

Table E-8 (continued)

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS USING A SINGLE TANK WITHOUT FORCED OXIDATION

Mist Elimination System Configuration	Three-pass, open-vane, 316L SS Chevron Mist Eliminator
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq. ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Spray tower turned off.
Method of Control	The inlet pH is controlled at 5.1 by limestone addition to EHT (D-101). Adipic acid addition is controlled to achieve various levels of adipic acid concentration. Recirculated solids controlled at 15% ± 1%.
Run Philosophy	These runs were designed to determine SO_2 removal in the venturi only, using limestone, various levels of adipic acid concentration, various levels of L/G and venturi pressure drop. The runs were made without forced oxidation.
Results: Run 927-1A:	SO_2 removal averaged 34% at 1990 ppm average inlet SO_2 concentration and 815 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.05. Limestone utilization averaged 92%. The make-per-pass averaged 8.35 m-mole/l.
Run 927-1B:	SO_2 removal averaged 39% at 2470 ppm average inlet SO_2 concentration and 705 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.15. Limestone utilization averaged 92%. The make-per-pass averaged 6.80 m-mole/l.
Run 927-1J:	SO_2 removal averaged 33% at 2390 ppm average inlet SO_2 concentration and 795 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.10. Limestone utilization averaged 91%. The make-per-pass averaged 7.65 m-mole/l.
Run 927-1C:	SO_2 removal averaged 47% at 2595 ppm average inlet SO_2 concentration and 1360 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.15. Limestone utilization averaged 91%. The make-per-pass averaged 8.65 m-mole/l.
Run 927-1D:	SO_2 removal averaged 41% at 2445 ppm average inlet SO_2 concentration and 1335 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.15. Limestone utilization averaged 83%. The make-per-pass averaged 12.40 m-mole/l.
Run 927-1E:	SO_2 removal averaged 65% of 2360 ppm average inlet SO_2 concentration and 3985 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.10. Limestone utilization averaged 85%. The make-per-pass averaged 19.0 m-mole/l.
Run 927-1F:	SO_2 removal averaged 67% at 2255 ppm average inlet SO_2 concentration and 3990 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.10. Limestone utilization averaged 85%. The make-per-pass averaged 14.70 m-mole/l.
Run 927-1G:	SO_2 removal averaged 68% at 2790 ppm average inlet SO_2 concentration and 4030 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.05. Limestone utilization averaged 85%. The make-per-pass averaged 13.40 m-mole/l.
Run 927-1H:	SO_2 removal averaged 69% at 3030 ppm average inlet SO_2 concentration and 4005 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.10. Limestone utilization averaged 88%. The make-per-pass averaged 20.35 m-mole/l.
Run 927-1I:	SO_2 removal averaged 65% at 2945 ppm average inlet SO_2 concentration and 4015 ppm average adipic acid concentration. The scrubber inlet pH averaged 5.10. Limestone utilization averaged 91%. The make-per-pass averaged 18.60 m-mole/l.
Run 927-1K:	SO_2 removal averaged 59% at 2245 ppm average inlet SO_2 concentration and 4050 ppm average adipic acid concentration. The scrubber inlet pH averaged 4.85. Limestone utilization averaged 93%. The make-per-pass averaged 12.90 m-mole/l.
Run 927-1L:	SO_2 removal averaged 62% at 2100 ppm average inlet SO_2 concentration and 4340 ppm average adipic acid concentration. The scrubber inlet pH averaged 4.80. Limestone utilization averaged 90%. The make-per-pass averaged 9.20 m-mole/l.

Table E-9

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	927-1M	927-1N	927-1O
Start-of-Run Date	3-21-80	2-26-80	3-30-80
End-of-Run Date	3-26-80	3-26-80	4-2-80
Onstream Hours	115	13	75
Fly Ash Loading	High	High	High
Adipic Acid Concentration, ppm	3830-4500	3860-4060	3880-4380
Gas Rate, acfm @ 300°F	30,000	20,000	20,000
Venturi Liquor Rate, gpm	600	600	600
Venturi L/G, gal/mcf	25	37	37
Percent Solids Recirculated	13.6-16.4	14.9-15.9	13.7-16.3
Oxidation Tank Residence Time, min.	10.6	10.6	10.6
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.56-2.44	2.75-2.93	1.14-1.25
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	50	35	85
Inlet O_2 Concentration, vol. %	3.2-5.3	3.7	3.9-5.2
Inlet SO_2 Concentration, ppm	2060-2460	1880-2190	1940-2200
Overall Percent SO_2 Removal	69-74	77-78	64-71
Average SO_2 Make-per-pass, m-mole/l	17.1	11.1	9.9
Scrubber Inlet pH Range	4.9-5.2	5.1-5.2	4.5-4.7
Scrubber Outlet pH Range	4.4-4.8	4.7	4.2-4.3
Percent Sulfite Oxidized in Scrubber Inlet Slurry	88.8-100.0	99.1-99.3	99.3-99.4
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	76-80	79	77-79
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	101	95	106
Scrubber Liquor Fe Concentration, ppm	9.3	15	0.5
Scrubber Liquor Mn Concentration, ppm	25.0	--	38
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	15100-17040	15600-16910	18300-18980
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	13.0-13.6	8.7-9.3	8.9-9.4
Venturi ΔP	8.7-9.3	6.8-7.2	7.0-7.3
Mist Elimination System ΔP Range, in H_2O	0.21-0.25	0.11-0.13	0.12-0.16
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.3 gpm/sq.ft.

Table E-9 (continued)

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	927-1M	927-1N	927-1O
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Venturi only. Spray tower turned off.	Venturi only. Spray tower turned off.	Venturi only. Spray tower turned off.
System Changes Before Start of Run	Spray tower turned off. No shutdown.	Spray tower turned off. No shutdown.	Spray tower turned off. No shutdown.
Method of Control	The inlet pH is controlled at 5.0 by limestone addition to EH/Oxidation Tank (D-208). Adipic Acidi concentration is controlled at 4000 ppm. Air rate to oxidizer controlled at 300 scfm. Recirculated slurry solids controlled at 15% ± 1%.	The inlet pH is controlled at 5.0 by limestone addition to EHT/Oxidation Tank (D-208). Adipic acid concentration is controlled at 4000 ppm. Air rate to oxidizer controlled at 300 scfm. Recirculated slurry solids controlled at 15 ± 1%.	The limestone stoichiometry is controlled at 1.2 by limestone addition to EHT/Oxidation Tank (D-208). Adipic acid concentration is controlled at 4000 ppm. Air rate to oxidizer controlled at 300 scfm. Recirculated slurry solids controlled at 15% ± 1%.
Run Philosophy	This run was added in an attempt to minimize limestone blinding and to explore SO_2 removal with a venturi only with single tank oxidation.	This run was added in an attempt to minimize blinding by reducing the gas rate, thereby decreasing the make-per-pass.	This run was made to determine the operating pH which would give good limestone utilization
Results	SO_2 removal averaged 71.5% at 2260 ppm inlet SO_2 concentration and 4170 ppm adipic acid concentration. The adipic acid consumption ratio (Actual/Theor.) was 1.60. Sulfite oxidation was 99.4%. Limestone utilization was 50%, indicating persistent limestone blinding. Centrifuge cake was 78% by wt. solids.	SO_2 removal averaged 77.4% at 2030 ppm inlet SO_2 concentration and 3960 ppm adipic acid concentration. The adipic acid consumption ratio (Actual/Theor.) was 1.47. Sulfite oxidation was 99.2%. Limestone utilization was 35%, indicating severe blinding. Centrifuge cake was 79% by wt. solids.	SO_2 removal averaged 67.4% at 2070 ppm inlet SO_2 concentration and 4130 ppm adipic acid concentration. The adipic consumption ratio (Actual/Theor.) was 1.0. Sulfite oxidation was 99.2% and limestone utilization was 85% at a venturi inlet pH of 4.55. Centrifuge cake was 78% by wt. solids.

Table E-9 (continued)

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	927-1P
Start-of-Run Date	4-2-80
End-of-Run Date	4-7-80
Onstream Hours	108
Fly Ash Loading	High
Adipic Acid Concentration, ppm	3800-4110
Gas Rate, acfm @ 300°F	30,000
Venturi Liquor Rate, gpm	600
Venturi L/G, gal/mcf	25
Percent Solids Recirculated	14.6-15.3
Effluent Hold Tank Residence Time, min.	10.6
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.51-2.40
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	54
Inlet O_2 Concentration, vol. %	3.6-5.6
Inlet SO_2 Concentration, ppm	2010-2440
Overall Percent SO_2 Removal	66-73
Average SO_2 Make-per-pass, m-mole/l	16.4
Scrubber Inlet pH Range	5.0-5.2
Scrubber Outlet pH	4.6-4.8
Percent Sulfite Oxidized in Scrubber Inlet Slurry	18-28
Solids Disposal System	Clarifier & Centrifuge
Solids in Sludge Discharged, %	59-66
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	125
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	16480-19850
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	12.2-12.9
Venturi ΔP	8.3-9.4
Mist Elimination System ΔP Range, in. H_2O	0.21-0.25
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at 0.53 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq.ft.

Table E-9 (continued)

SUMMARY OF VENTURI LIMESTONE/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	927-1P
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.
System Changes Before Start of Run	Spray tower turned off. No shutdown.
Method of Control	The inlet pH is controlleld at 5.0 by limestone addition to EHT/Oxidation Tank D-208. Adipic acid concentration is controlled at 4000 ppm. Recirculated slurry solids controlled at 15% ± 1%.
Run Philosophy	The purpose of this run was to serve as a baseline test without forced oxidation to use for comparison with Run 927-1M, reported in the March Monthly Technical Report.
Results	SO_2 removal averaged 69.6% at 2225 ppm inlet SO_2 concentration and 3960 ppm adipic acid concentration. The adipic acid consumption ration (Actual/Theor.) was 1.65. Sulfite oxidation was 23%. Limestone utilization was 54%, indicating severe limestone blinding. Centrifuge cake was 63% by wt. solids.

Table E-10

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIME SLURRY

Run Number	951-1A	952-1A	
Start-of-Run Date	7/3/78	7/20/78	
End-of-Run Date	7/12/78	8/3/78	
On Stream Hours	205	278	
Fly Ash Loading	High	High	
Adipic Acid Addition	No	Yes	
Gas Rate, acfm @ 300°F	35,000	35,000	
Spray Tower Gas. Vel., ft/sec @125°F	9.4	9.4	
Venturi Liquor Rate, gpm	600	600	
Venturi L/G, gal/Mcf	21	21	
Spray Tower Liquor Rate, gpm	1600	1600	
Spray Tower L/G, gal/Mcf	57	57	
Venturi Percent Solids Recirculated	14.3 - 17.1	12.0 - 19.2	
Spray Tower Percent Solids Recirculated	4.6 - 6.8	2.1 - 6.8	
Venturi Oxidation Tank Residence Time, min.	11.3	11.3	
Venturi Desupersaturation Tank Residence Time, min.	4.7	4.7	
Spray Tower Effluent Residence Time, min.	14.7	14.7	
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	
Stoichiometric Ratio in Venturi Inlet Slurry, moles Ca/mole SO_2	1.01 - 1.06	1.01 - 1.03	
Stoichiometric Ratio in Spray Tower Inlet Slurry, moles Ca/mole SO_2	1.07 - 1.21	1.08 - 1.38	
Overall Ave. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	97	98	
Inlet O_2 Concentration, vol. %	6.4 - 8.0	5.0 - 8.0	
Inlet SO_2 Concentration, ppm	2200 - 3300	1900 - 3300	
Overall Percent SO_2 Removal	60 - 72	97 - 99	
Avg. SO_2 Make-per-pass, m-mole/l	6.3	8.4	
Venturi Inlet pH Range	5.3 - 5.8	5.2 - 5.8	
Venturi Outlet pH Range	4.3 - 4.7	4.0 - 4.7	
Spray Tower Inlet pH Range	7.4 - 8.4	7.5 - 8.0	
Spray Tower Outlet pH Range	4.9 - 5.3	5.3 - 6.3	
Percent Sulfite Oxidized in Venturi Inlet Slurry	91 - 99	95 - 99	
Percent Sulfite Oxidized in Spray Tower Inlet Slurry	9 - 26	6 - 38	
Air Flow Rate to Oxidizer, scfm	210	260	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.05	1.80	
Solids in Sludge Discharged, %	82 - 89	81 - 88	
Calculated Avg. % Gypsum Saturation in Venturi Inlet Liquor @ 50°C	95	90	
Calculated Avg. % Gypsum Saturation in Spray Tower Inlet Liquor @ 50°C	90	85	
Total Dissolved Solids in Venturi Inlet Liquor, ppm	4300 - 7100	8140 - 10840	
Total Dissolved Solids in Spray Tower Inlet Liquor, ppm	3300 - 4700	5980 - 8330	
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	15.2 - 16.4	13.9 - 17.4	
Venturi ΔP (nominal), in H_2O	9	9	
Mist Elimination System ΔP Range, in. H_2O	0.60 - 0.68	0.50 - 0.68	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Wash Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq ft. for 6 min. every 4 hours.	Top washed sequentially with makeup water. Each nozzle (6 total) on 4 min. (at 0.53 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water through 10 nozzles at 1.5 gpm/sq.ft. for 6 min. every 4 hours.	

Table E-10 (continued)

SUMMARY OF VENTURI/SPRAY TOWER TWO-LOOP TESTS WITH FORCED OXIDATION ADIPIC ACID ENHANCED LIME SLURRY

Run Number	951-1A	952-1A	
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 3 inches from the bottom of the tank. Oxidation tank diameter is 8 ft. Tank slurry level was 18 ft.	
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank.	Lime slaked to a 20 wt% slurry with makeup water and added to venturi downcomer and spray tower hold tank. Adipic acid dry fed to spray tower hold tank.	
Scrubber Internals	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	Four spray headers. Top 3 headers sprayed downward. Bottom header sprayed upward. 7 nozzles/header.	
System Changes Before Start of Run	Cleaned scrubber wall below trapout tray, underneath trapout tray, I.D. fan damper, Hauck reheater shell, flooded elbow, and crossover line. Switched from limestone to lime. No other changes.	Switched from limestone to lime. No other changes. No cleaning. Installed new corrosion coupons racks below mist eliminator in spray tower EHT.	
Method of Control	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor and makeup water in excess of mist eliminator wash returned to the spray tower EHT.	Venturi inlet pH controlled at 5.5 ± 0.2 and spray tower inlet pH at 7.8 ± 0.2 by separate lime additions. Venturi recirculated slurry solids controlled at 15 ± 1%. Clarified liquor and makeup water in excess of mist eliminator wash returned to the spray tower EHT. Adipic acid concentration in spray tower controlled at 1500 ppm.	
Run Philosophy	A base case two-staged forced oxidation lime run without adipic acid. The results will be compared with succeeding lime/adipic acid runs to observe the effect of adipic acid on SO_2 removal.	The objective was to observe the effects of 1500 ppm adipic acid concentration in the spray tower and about 2000 ppm in the venturi on the SO_2 removal. (cf. Run 951-1A without adipic acid.)	
Results	SO_2 removal averaged 66% at 2750 ppm average inlet SO_2 concentration. Average sulfite oxidation was 95%. The filter cake solids content averaged 86%. The mist eliminator was 0.5% restricted at the end of the run.	SO_2 removal averaged 98% at 2600 ppm average inlet SO_2 concentration. Average sulfite oxidation was 97%. The adipic acid concentration averaged 1585 ppm in the venturi and 1380 ppm in the spray tower. The filter cake solids content averaged 85%. The mist eliminator was 1% restricted at the end of the run	

APPENDIX F

GRAPHICAL OPERATING DATA FROM THE VENTURI/SPRAY TOWER AND SPRAY TOWER TESTS

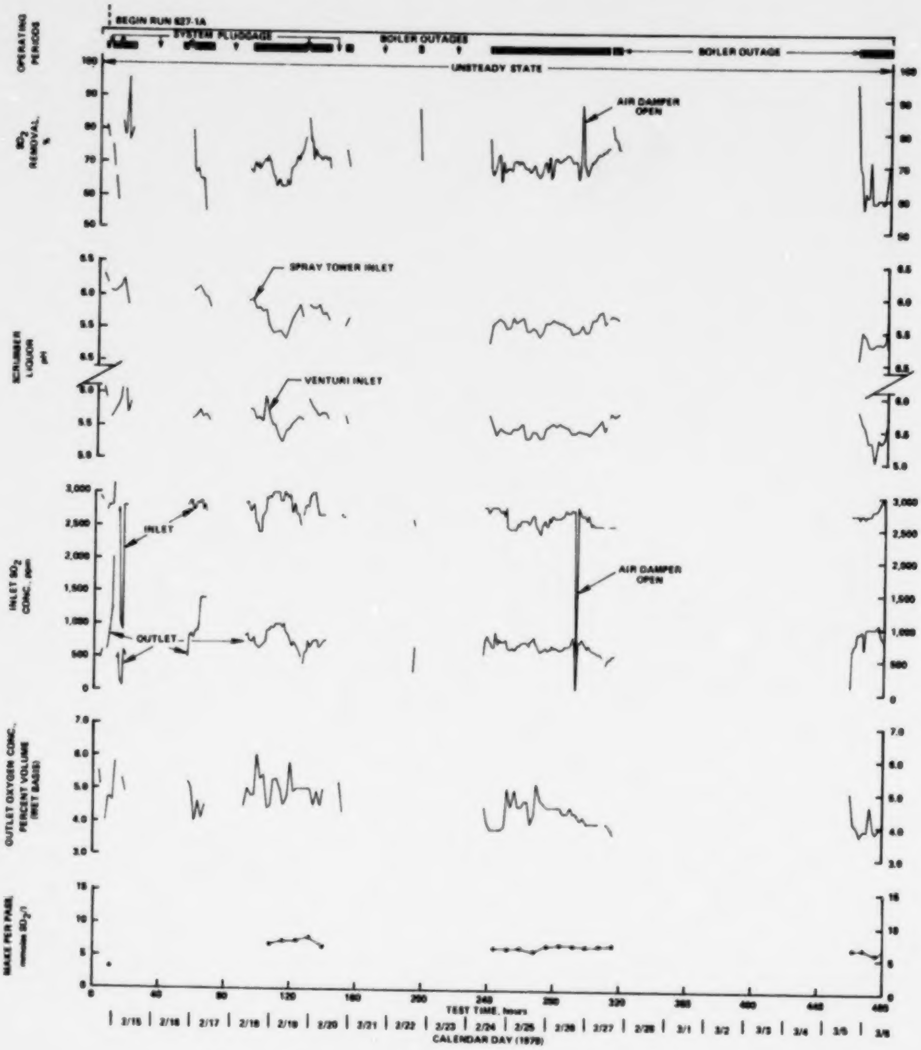


Figure F-1. Operating Data For Venturi/Spray Tower Run 827-1A

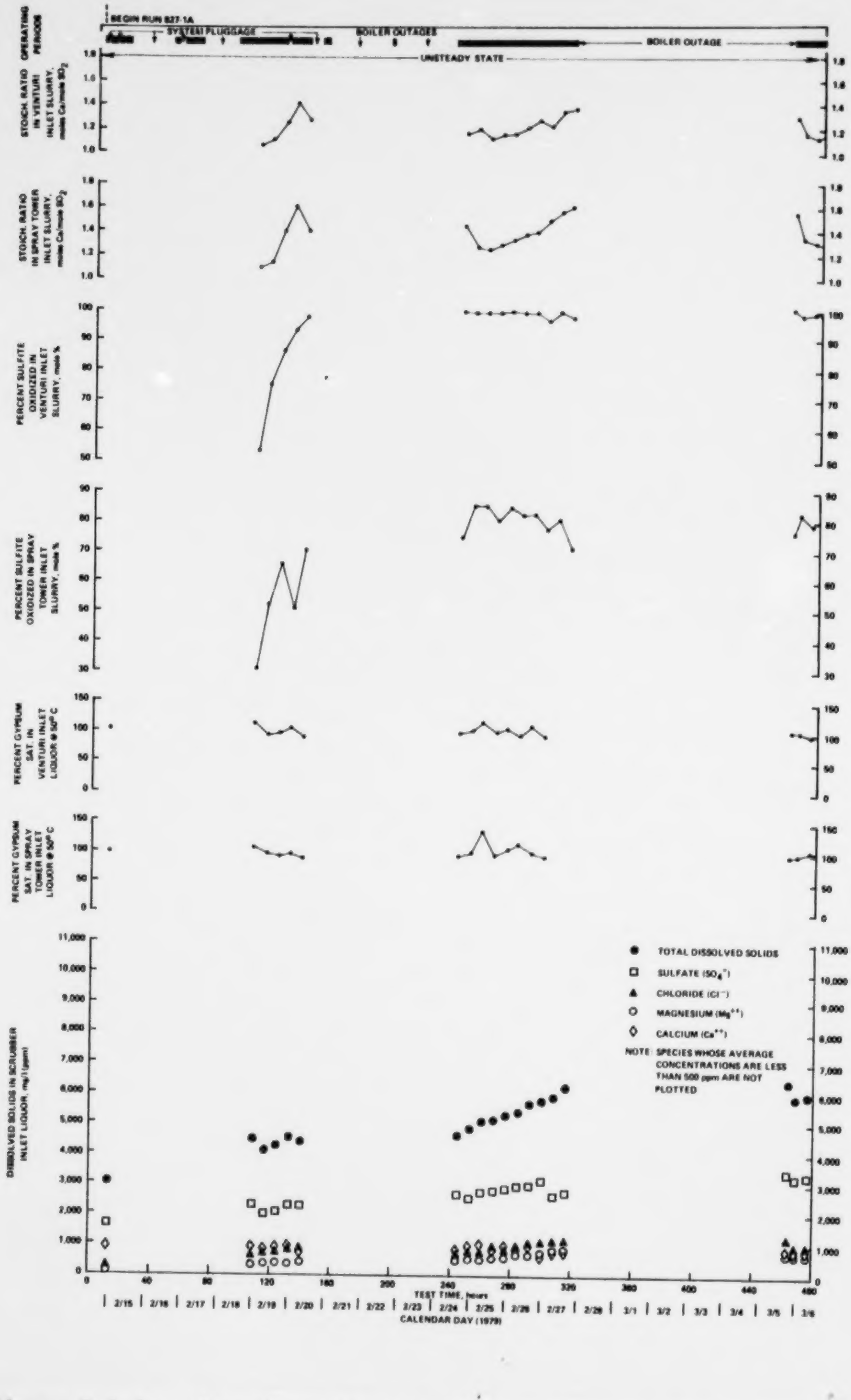


Figure F-1 (continued). Operating Data For Venturi/Spray Tower Run 827-1A

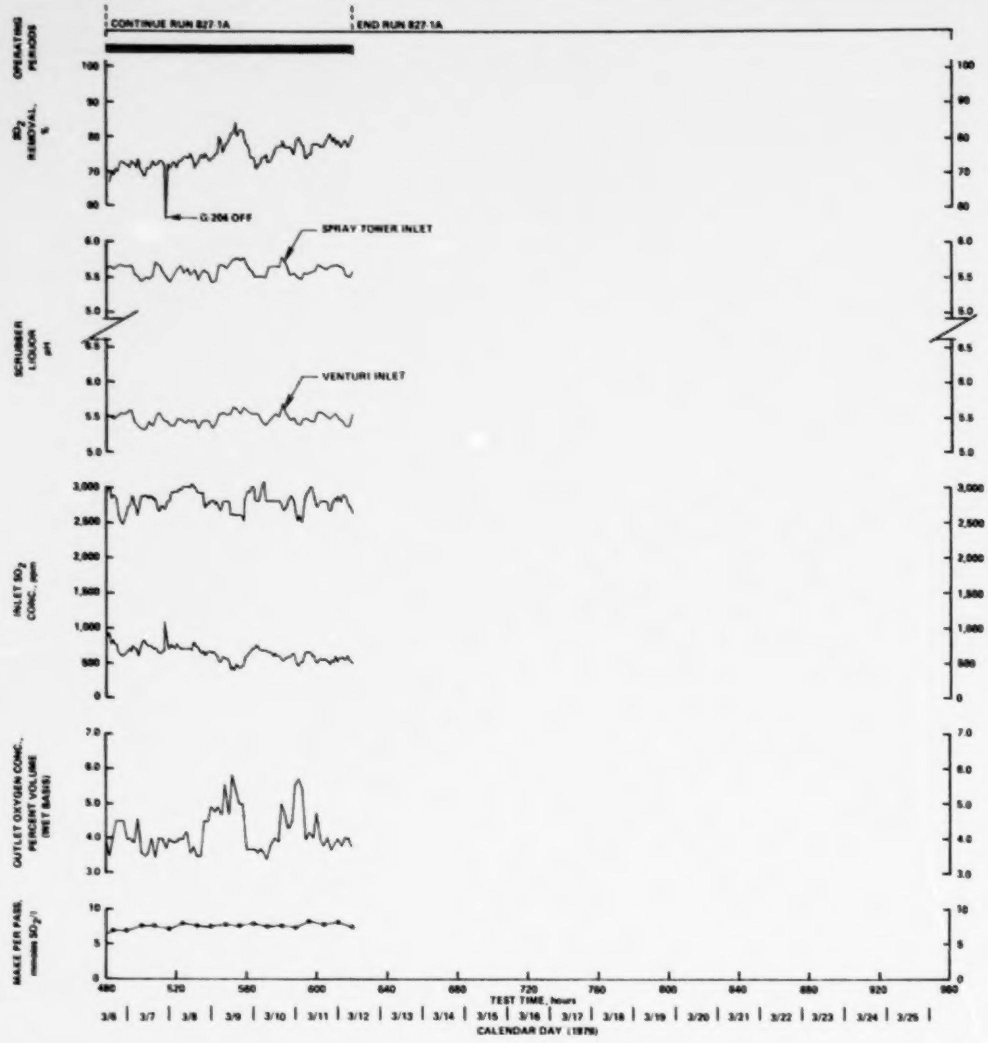
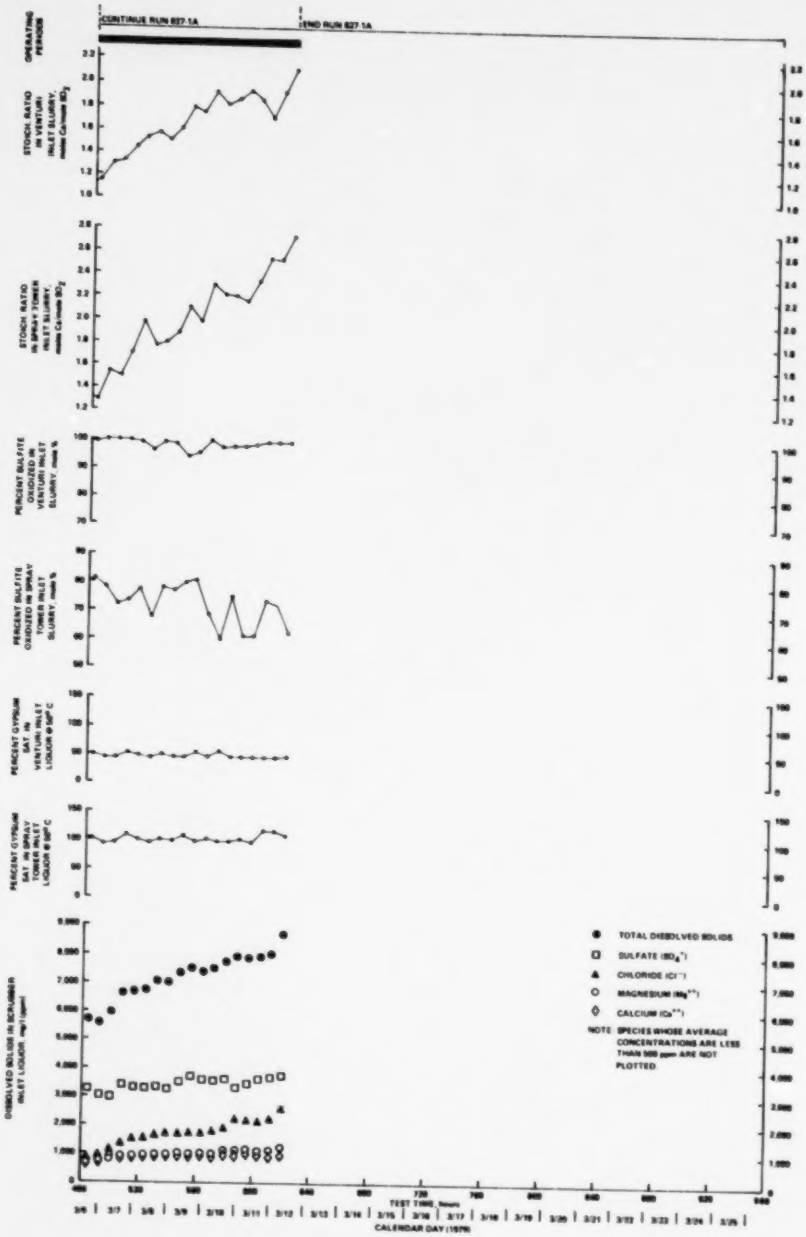


Figure F-1 (continued). Operating Data For Venturi/Spray Tower Run 827-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1500 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 53 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 9.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank 4.7 min
Solids Recirculated, Venturi Loop = 11.7 - 13.3 wt %
Solids Recirculated, Spray Tower Loop = 9.7 - 11.7 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.0 - 16.6 in. H_2O
Mist Elim. Pressure Drop = 0.59 - 0.72 in. H_2O
Air Flow Rate to Oxidizer = 250 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 81 - 88 wt %
Widows Creek (Stoneman) Limestone Addition
  to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  & Oxidation Tank
Backmix Slurry Flow from Venturi to Spray Tower
  Loop = 65 gpm

Figure F-1 (continued). Operating Data For Venturi/Spray Tower Run 827-1A

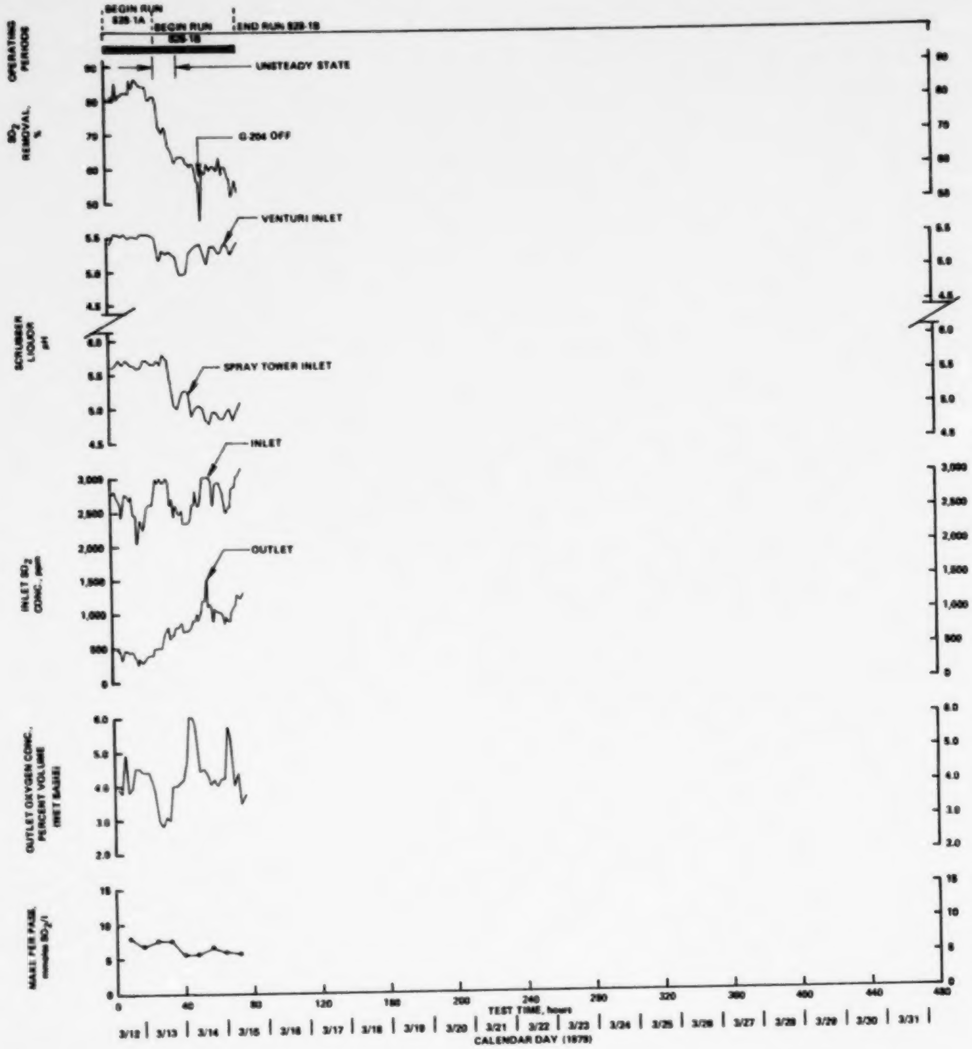
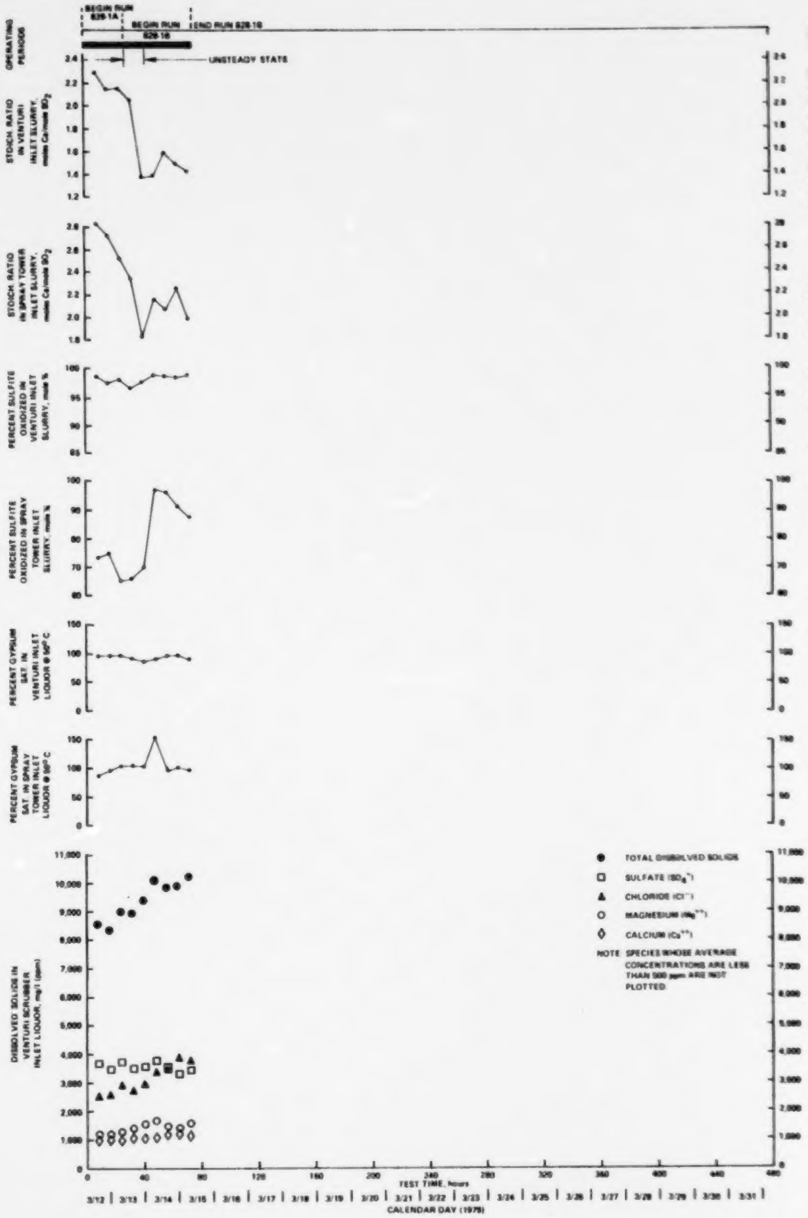


Figure F-2. Operating Data For Venturi/Spray Tower Runs 828-1A And 828-1B



828-1A

Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1500 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 53 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 9.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 11.6 - 12.4 wt %
Solids Recirculated, Spray Tower Loop = 10.6 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.9 - 15.7 in. H_2O
Mist Elim. Pressure Drop = 0.62 - 0.67 in. H_2O
Air Flow Rate to Oxidizer = 180 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 83 - 85 wt %
Widows Creek (Stoneman) Limestone Addition
  to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  & Oxidation Tank
Backmix Slurry Flow from Venturi to Spray Tower
  Loop = 65 gpm

828-1B

Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1500 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 53 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 9.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 11.1 - 13.3 wt %
Solids Recirculated, Spray Tower Loop = 9.7 - 11.5 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.7 - 15.6 in. H_2O
Mist Elim. Pressure Drop = 0.61 - 0.71 in. H_2O
Air Flow Rate to Oxidizer = 180 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 79 - 88 wt %
Widows Creek (Stoneman) Limestone Addition
  to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  & Oxidation Tank
Backmix Slurry Flow from Venturi to Spray Tower
  Loop = 65 gpm

Figure F-2 (continued). Operating Data For Venturi/Spray Tower Runs 828-1A And 828-1B

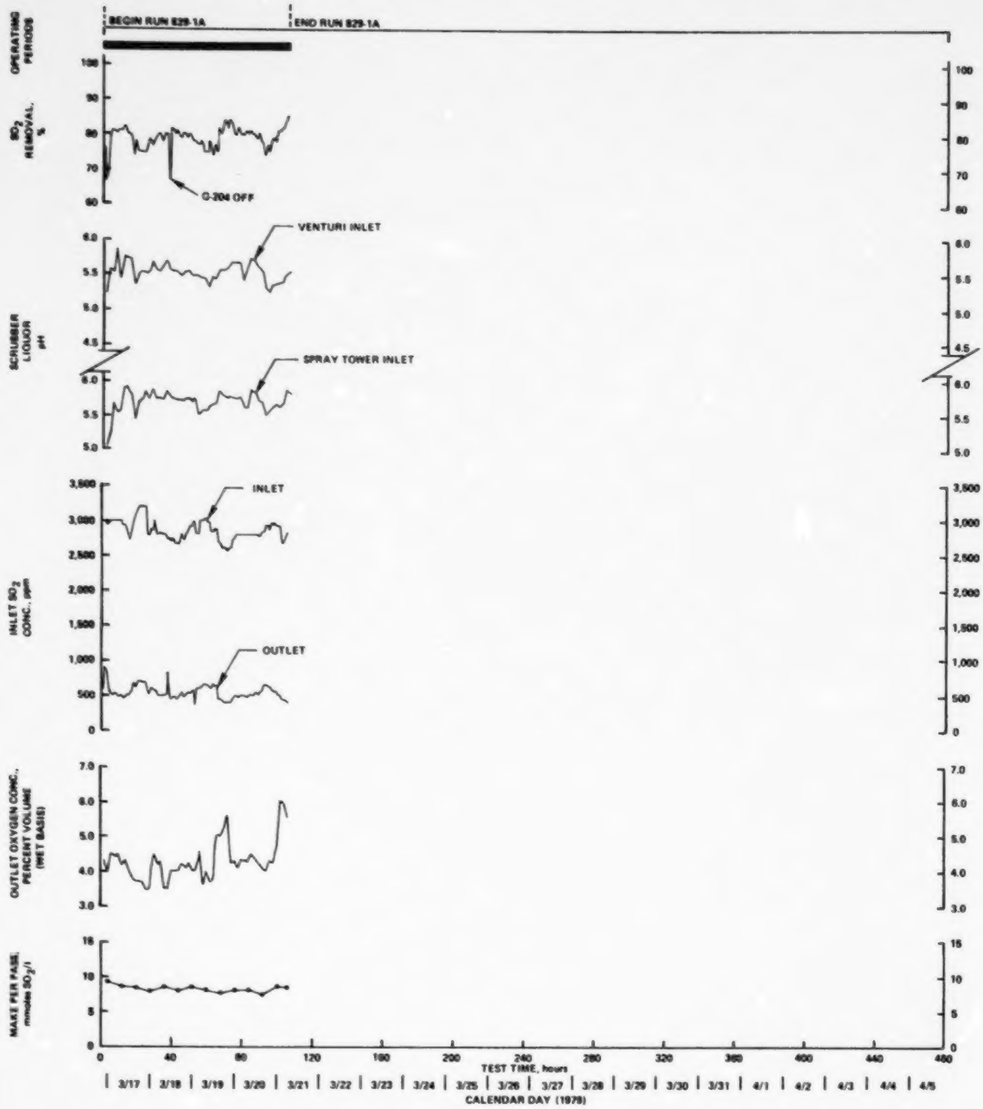
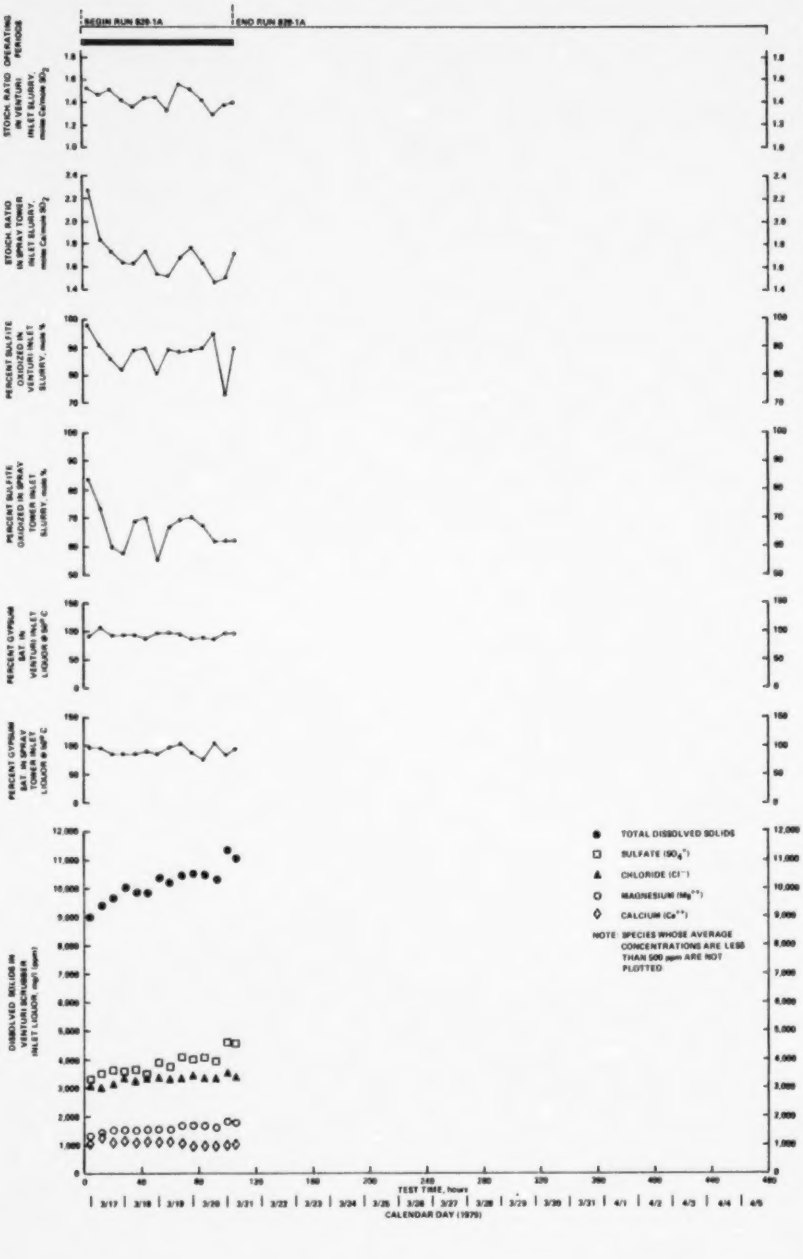


Figure F-3. Operating Data For Venturi/Spray Tower Run 829-1A



Gas Rate = 35,000 acfm @ 300^0 F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125^0 F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1500 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 53 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 9.4 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 11.5 - 13.3 wt %
Solids Recirculated, Spray Tower Loop = 9.4 - 11.6 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.3 - 16.1 in. H_2O
Mist Elim. Pressure Drop = 0.60 - 0.69 in. H_2O
Air Flow Rate to Oxidizer = 145 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 73 - 84 wt %
Widows Creek (Stoneman) Limestone Addition
  to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  & Oxidation Tank
Backmix Slurry Flow from Venturi to Spray Tower
  Loop = 65 gpm

Figure F-3 (continued). Operating Data For Venturi/Spray Tower Run 829-1A

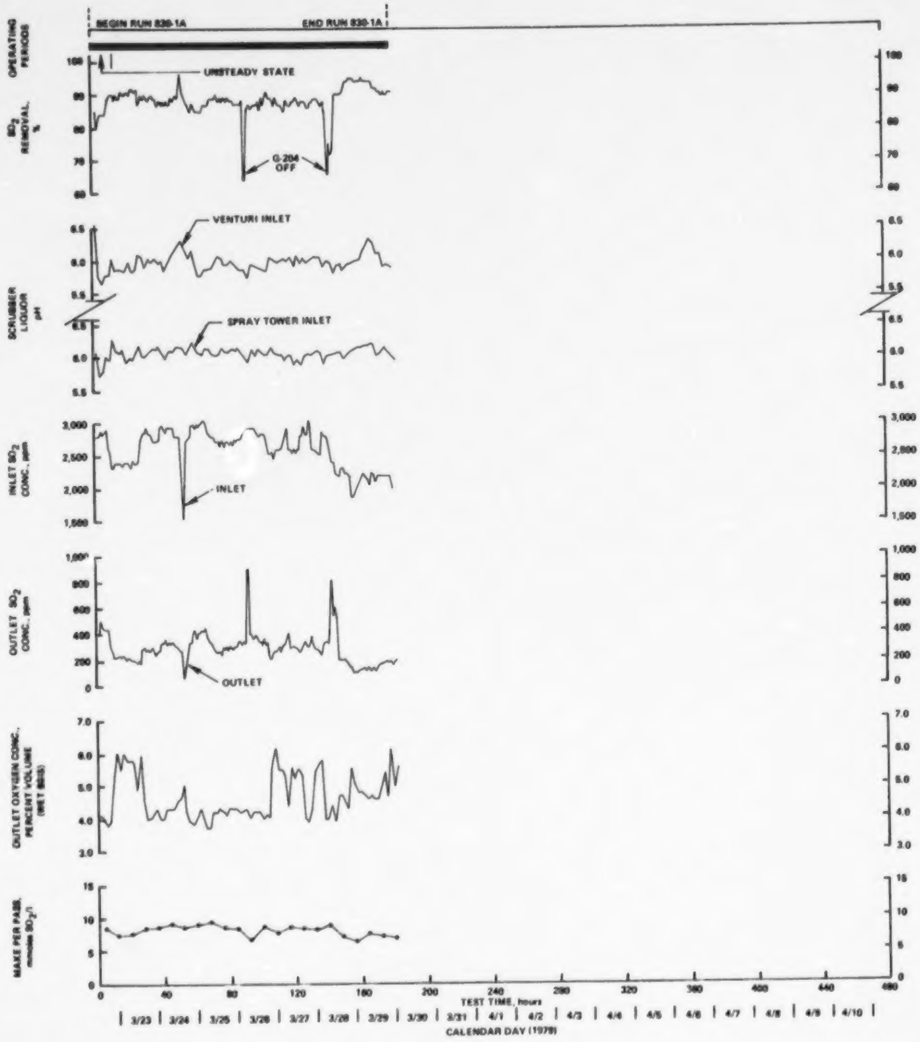
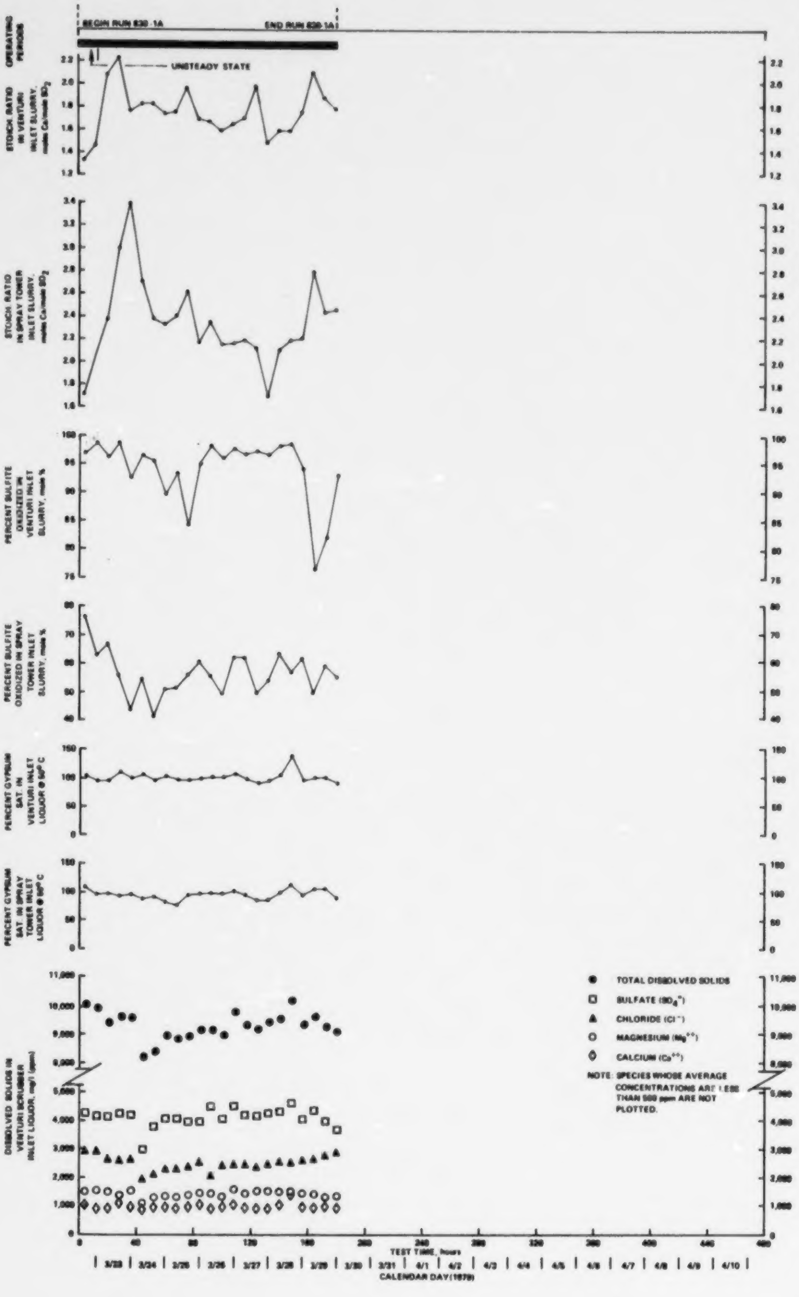
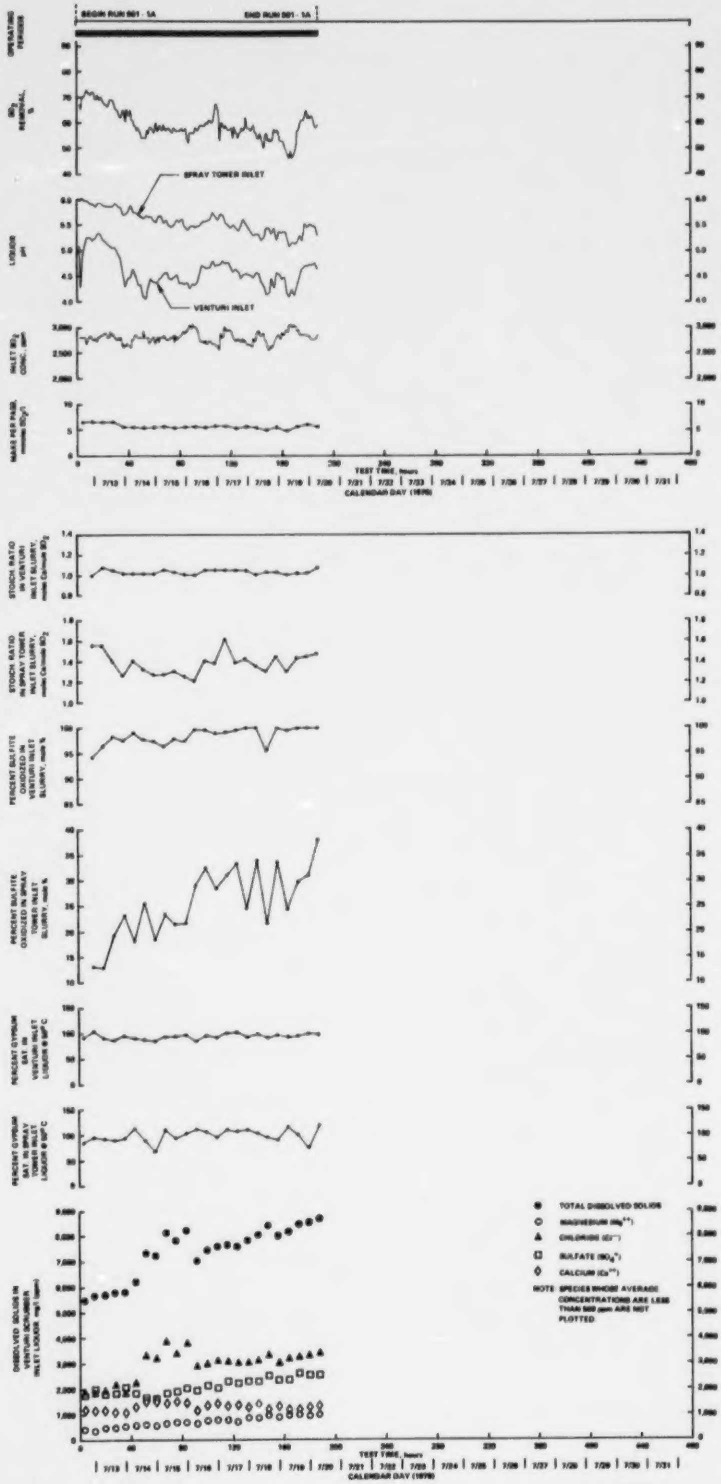


Figure F-4. Operating Data For Venturi/Spray Tower Run 830-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1500 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower EHT L/G = 53 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 9.4 min
  Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 10.4 - 13.0 wt %
Solids Recirculated, Spray Tower Loop = 8.7 - 11.1 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 13.9 - 17.3 in. H_2O
Mist Elim. Pressure Drop = 0.48 - 0.70 in. H_2O
Air Flow Rate to Oxidizer = 250 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 72 - 86 wt %
Widows Creek (Stoneman) Limestone Addition
  to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  & Oxidation Tank
Backmix Slurry Flow from Venturi to Spray Tower
  Loop = 29 gpm

Figure F-4 (continued). Operating Data For Venturi/Spray Tower Run 830-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.6 - 16.4 wt %
Solids Recirculated, Spray Tower Loop = 4.8 - 7.0 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.4 - 16.9 in. H_2O
Mist Elim. Pressure Drop = 0.60 - 0.68 in. H_2O
Air Flow Rate to Oxidizer = 210 acfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82 - 88 wt %
Limestone Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-5. Operating Data For Venturi/Spray Tower Run 901-1A

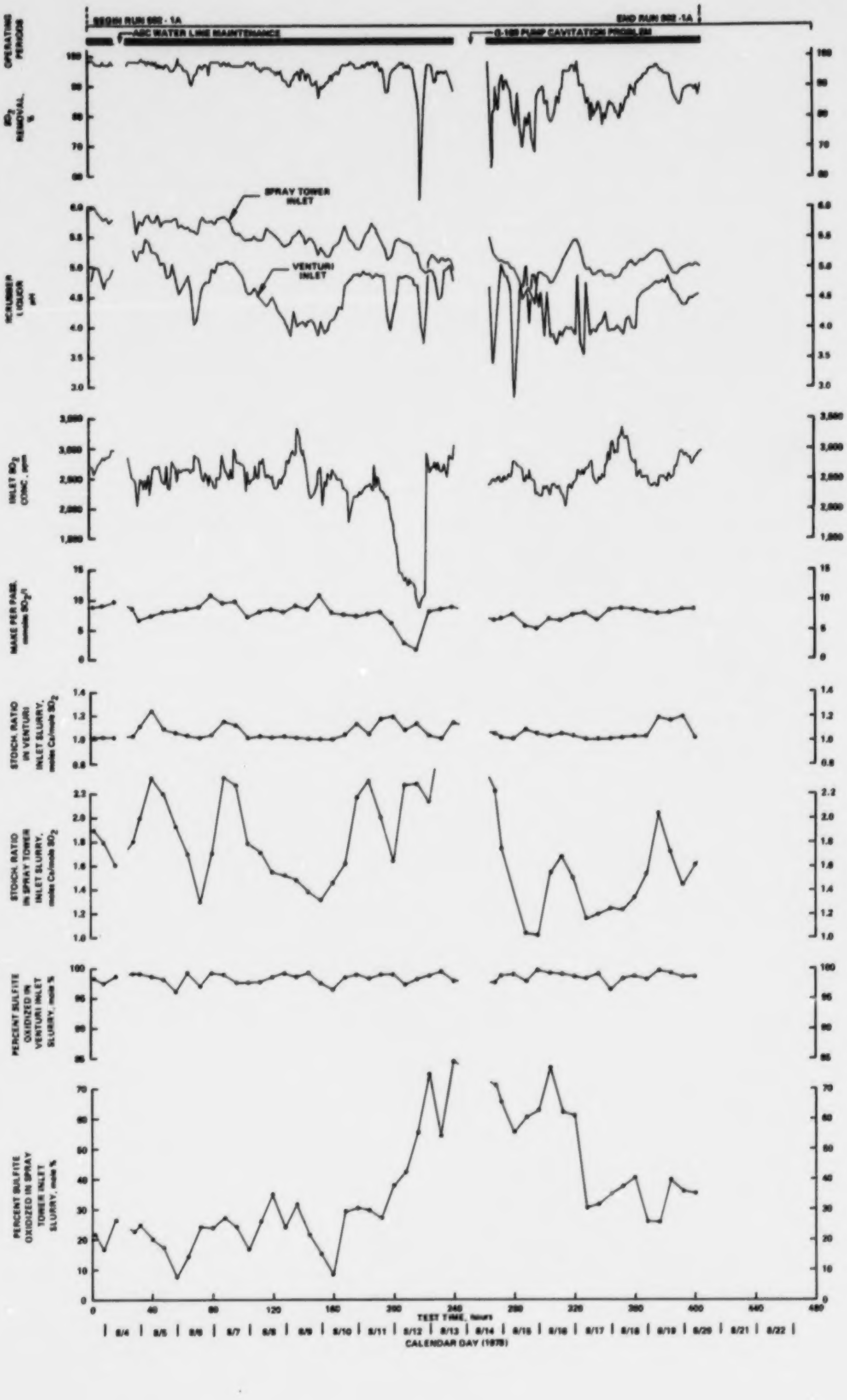
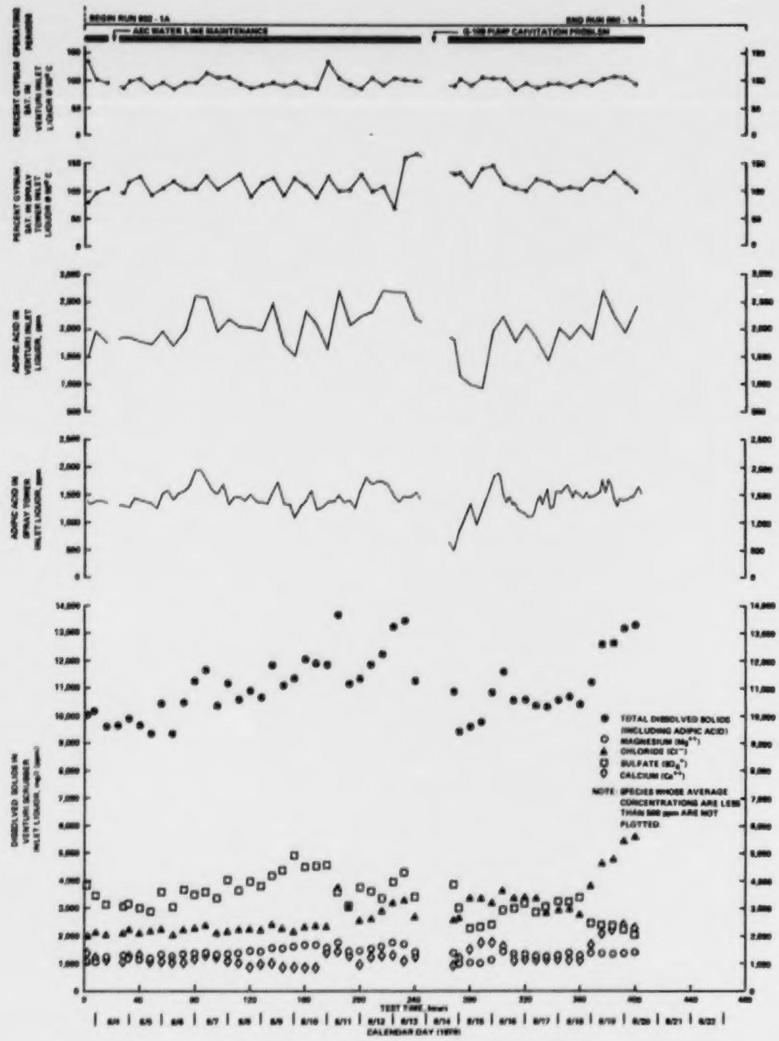


Figure F-6. Operating Data For Venturi/Spray Tower Run 902-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
    Spray Tower Hold Tank = 14.7 min
    Oxidation Tank = 11.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.4 - 17.6 wt %
Solids Recirculated, Spray Tower Loop = 3.5 - 6.3 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 15.2 - 18.5 in. H_2O
Mist Elim. Pressure Drop = 0.58 - 0.76 in. H_2O
Air Flow Rate to Oxidizer = 260 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 80 - 92 wt %
Limestone & Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-6 (continued). Operating Data For Venturi/Spray Tower Run 902-1A

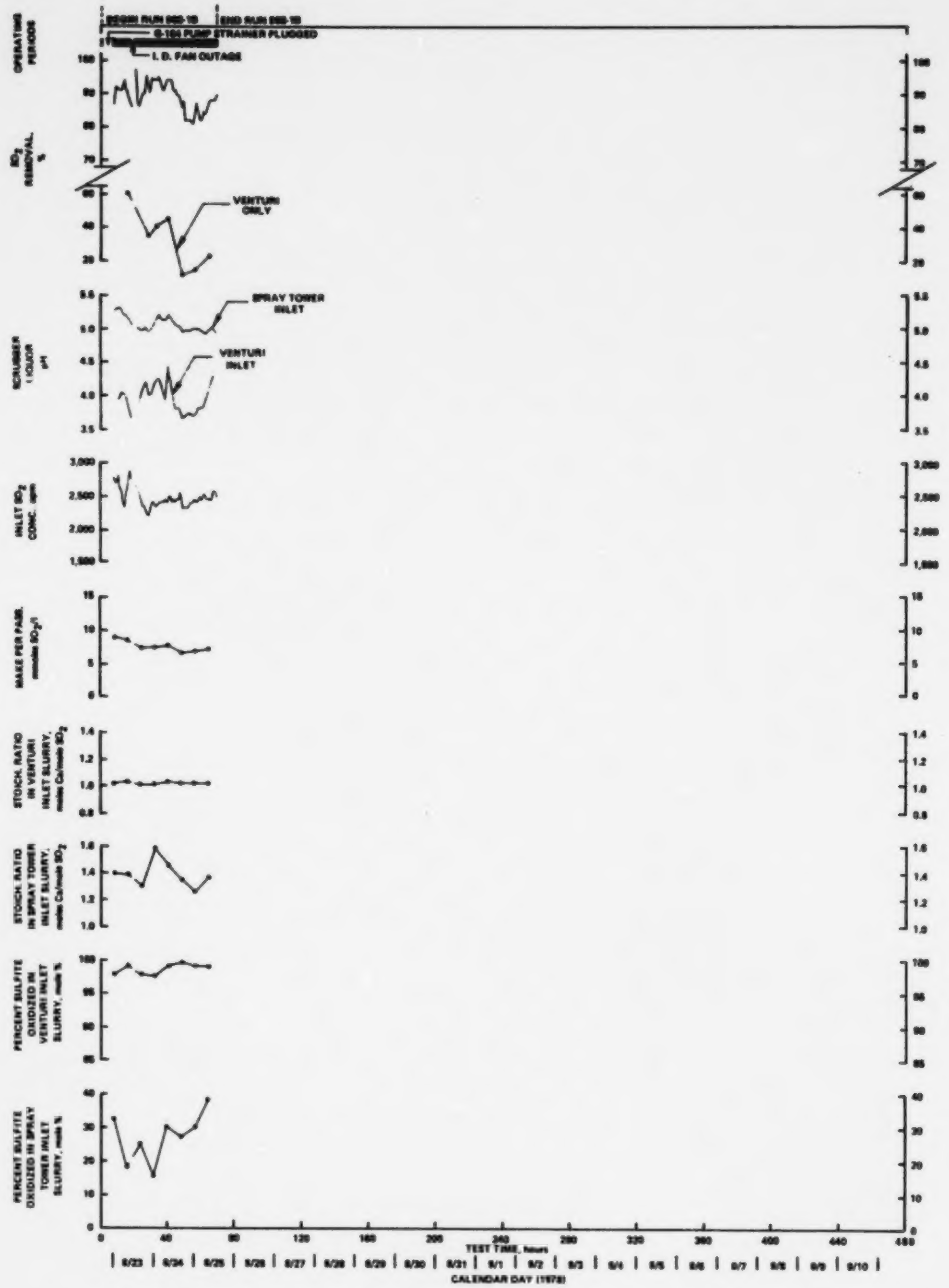
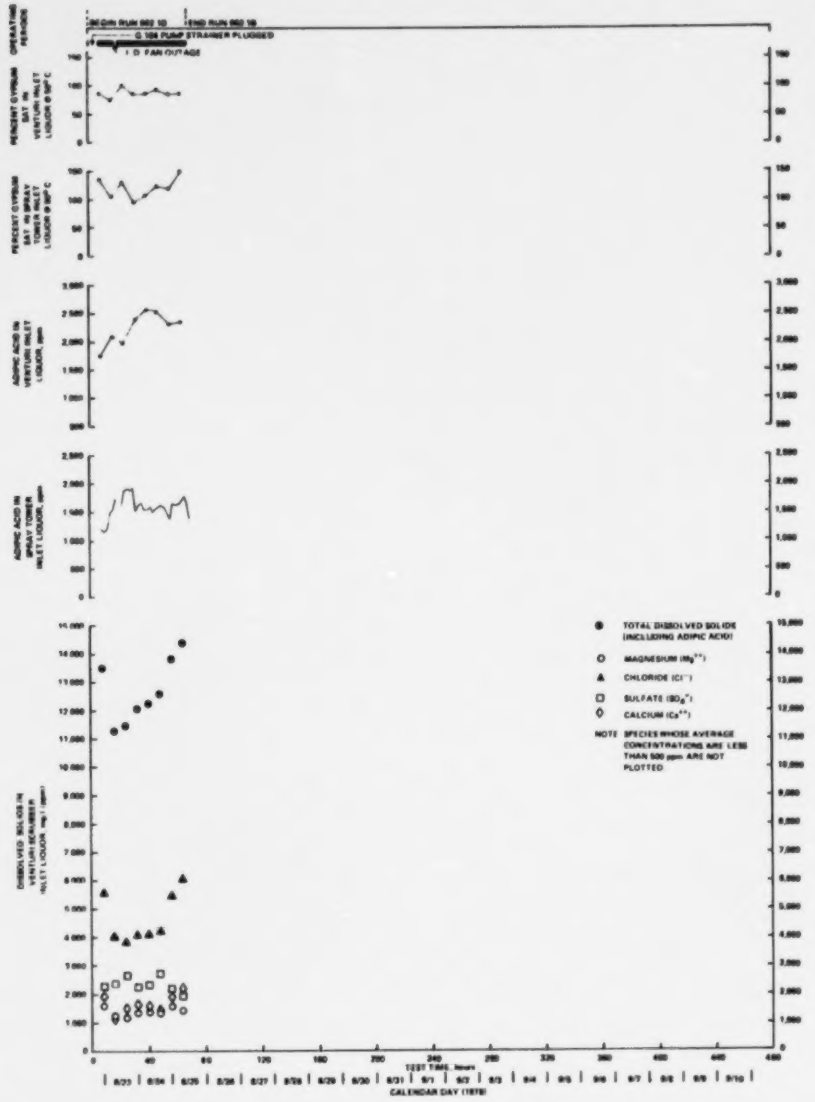
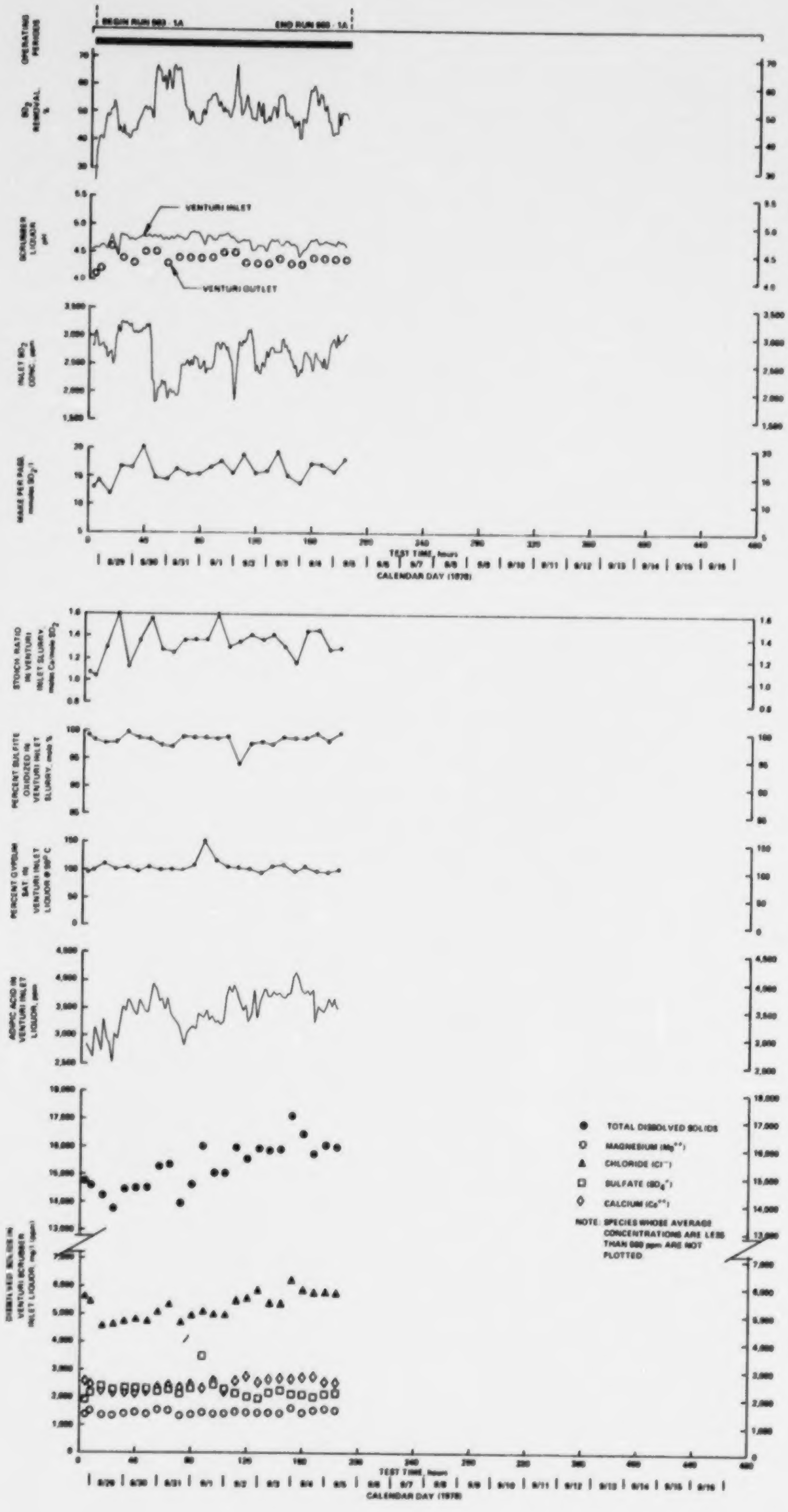


Figure F-7. Operating Data For Venturi/Spray Tower Run 902-1B



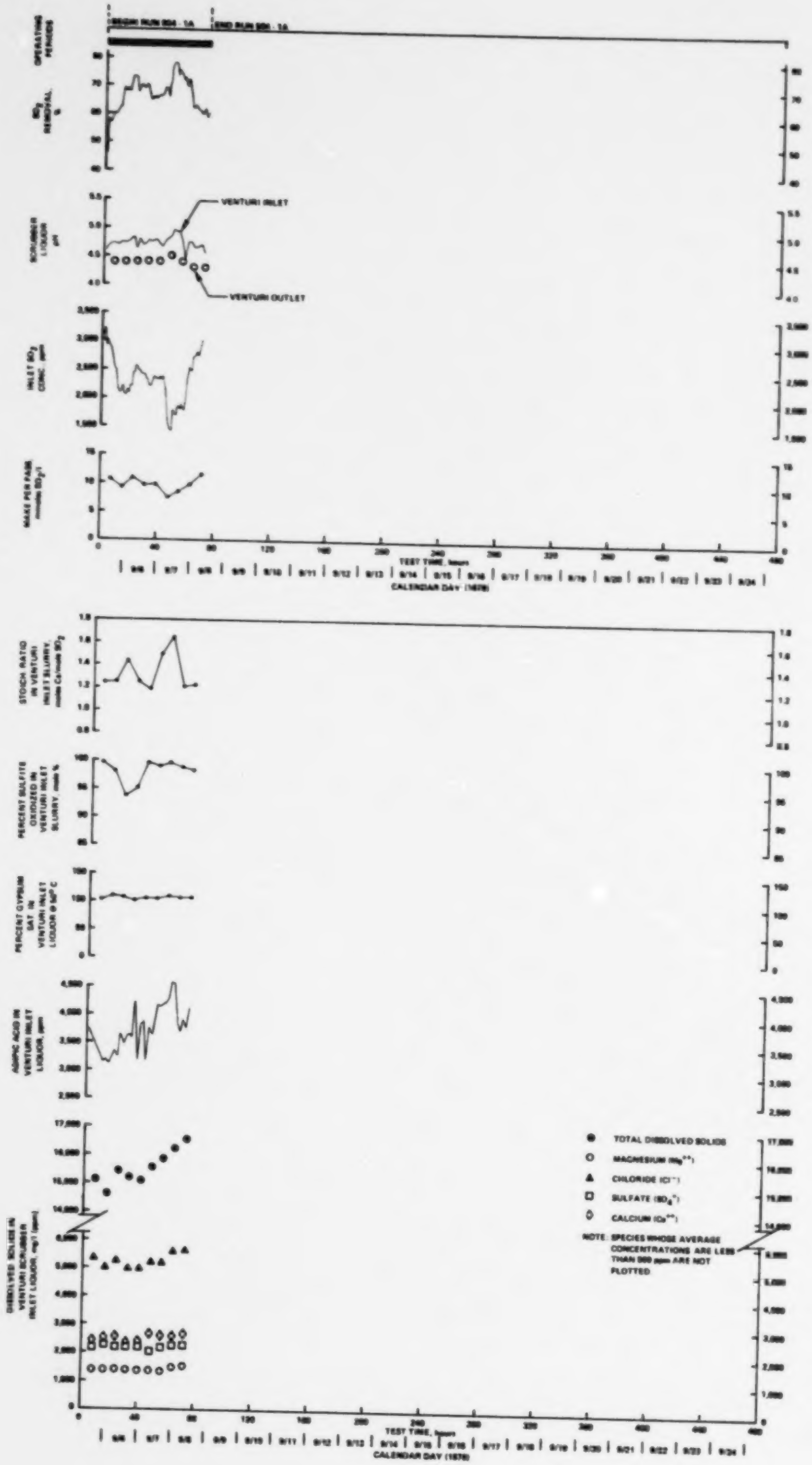
Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 800 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min.
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.3 - 16.5 wt %
Solids Recirculated, Spray Tower Loop = 4.7 - 4.9 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.5 - 16.9 in. H_2O
Mist Elim. Pressure Drop = 0.59 - 0.69 in. H_2O
Air Flow Rate to Oxidizer = 200 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 85 - 91 wt %
Limestone & Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-7 (continued). Operating Data For Venturi/Spray Tower Run 902-1B



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 21 gal/Mcf
Residence Times:
Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.0 - 16.0 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 13.7 - 14.6 in. H_2O
Mist Elim. Pressure Drop = 0.58 - 0.64 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 77 - 89 wt %
Limestone Addition to Desupersaturation Tank
Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-8. Operating Data For Venturi/Spray Tower Run 903-1A



Gas Rate = 18,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.8 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 42 gal/Mcf
Residence Times:
Oxidation Tank = 11.3 min
Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 11.0 - 13.6 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim. = 9.6 - 10.6 in. H_2O
Mist Elim. Pressure Drop = 0.18 - 0.23 in. H_2O
Air Flow Rate to Oxidizer = 130 scfm
Discharge (Clarifier & Filter) Solids Concentration = 75 - 85 wt %
Limestone Addition to Desupersaturation Tank
Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-9. Operating Data For Venturi/Spray Tower Run 904-1A

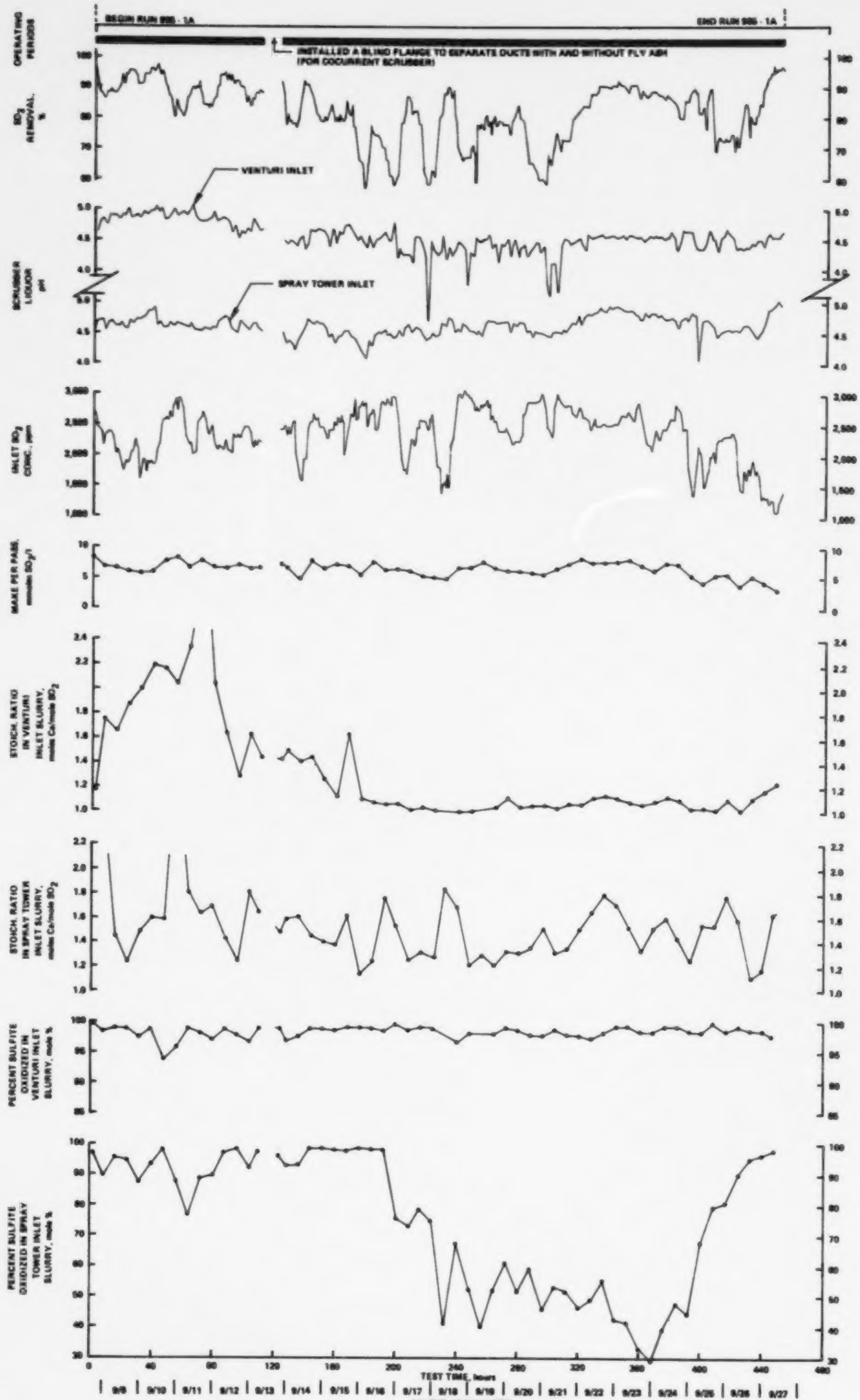
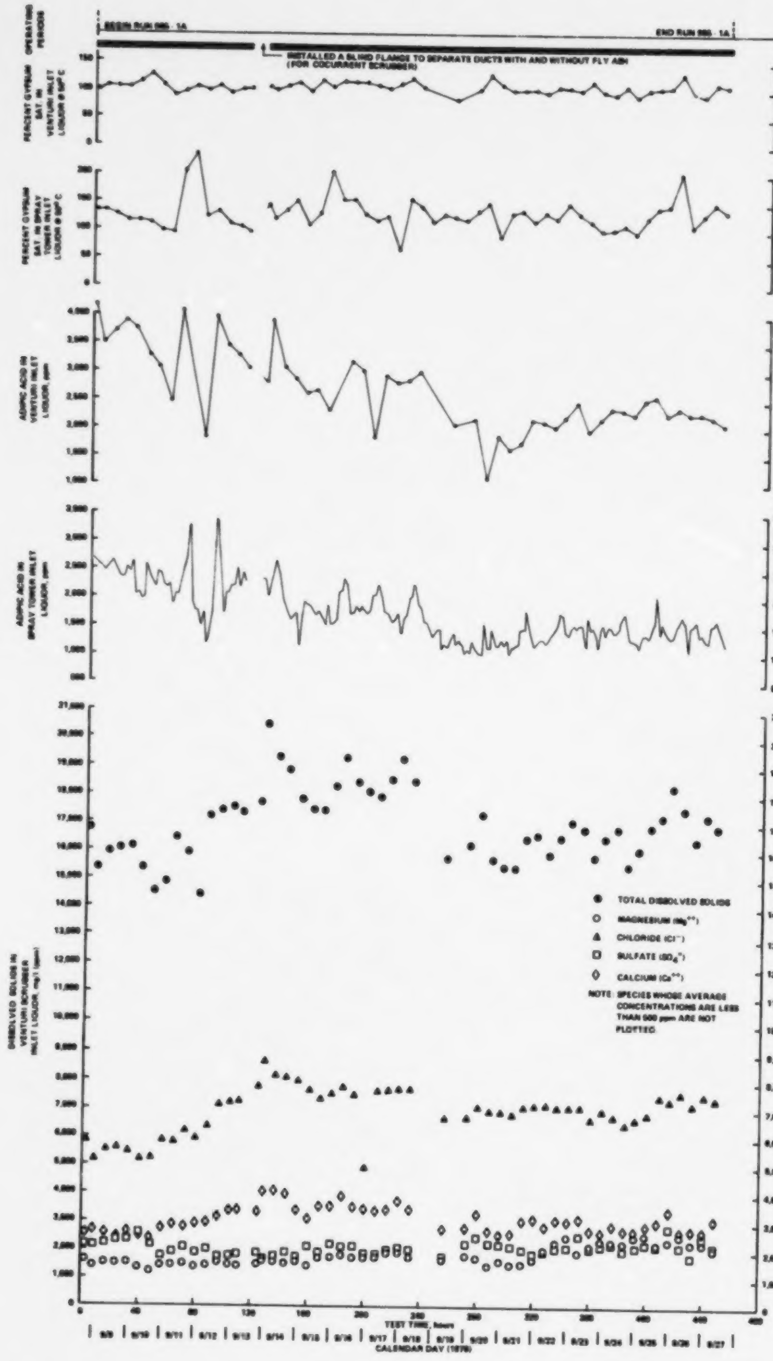


Figure F-10. Operating Data For Venturi/Spray Tower Run 905-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.7 - 15.5 wt %
Solids Recirculated, Spray Tower Loop = 2.3 - 4.1 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop Excl. Mist Elim.
  = 15.5 - 17.1 in. H_2O
Mist Elim. Pressure Drop = 0.55 - 0.65 in. H_2O
Air Flow Rate to Oxidizer = 260 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82 - 88 wt %
Limestone Addition to Spray Tower EHT
  and to Desupersaturation Tank
Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-10 (continued). Operating Data For Venturi/Spray Tower Run 905-1A

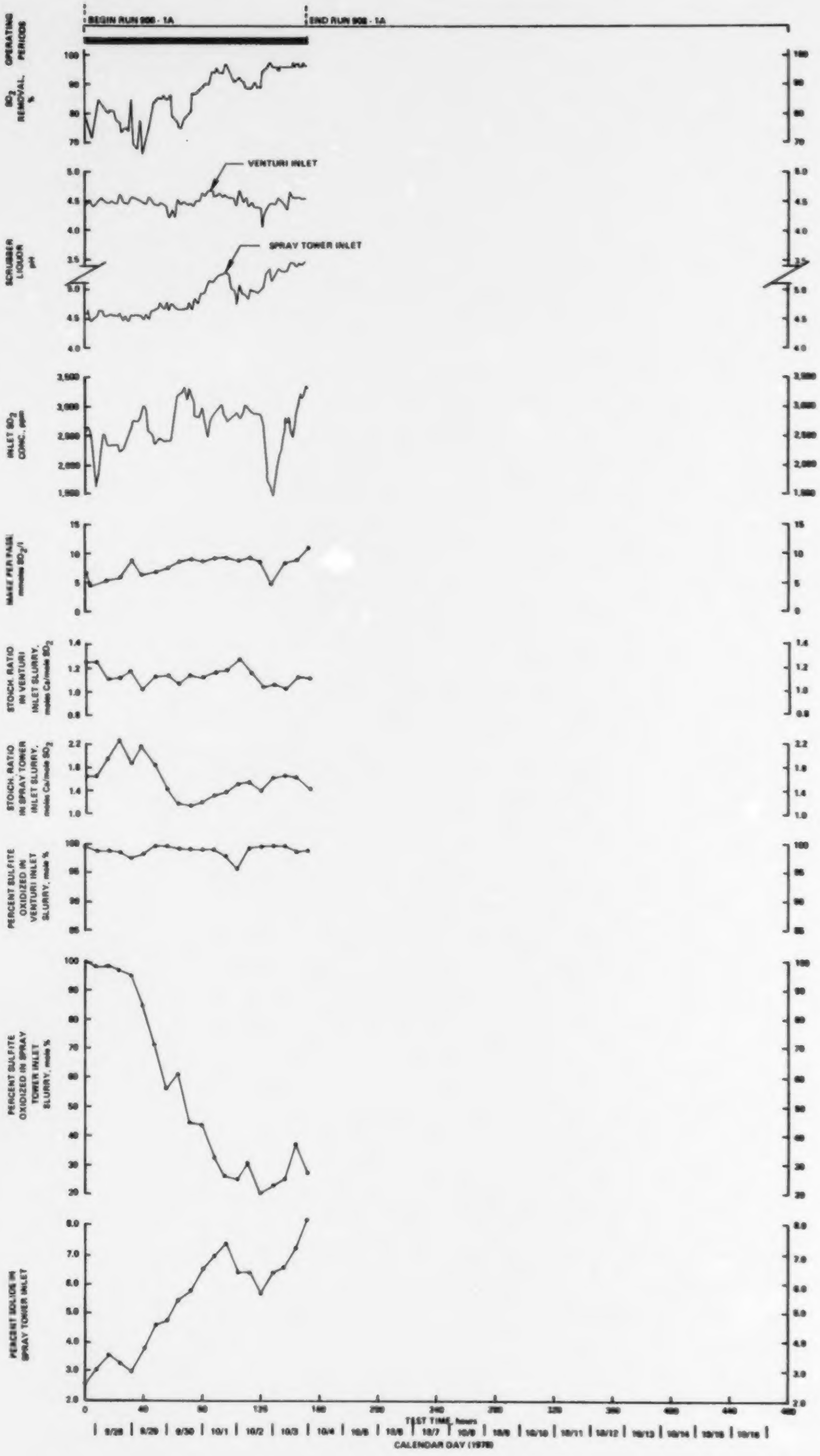
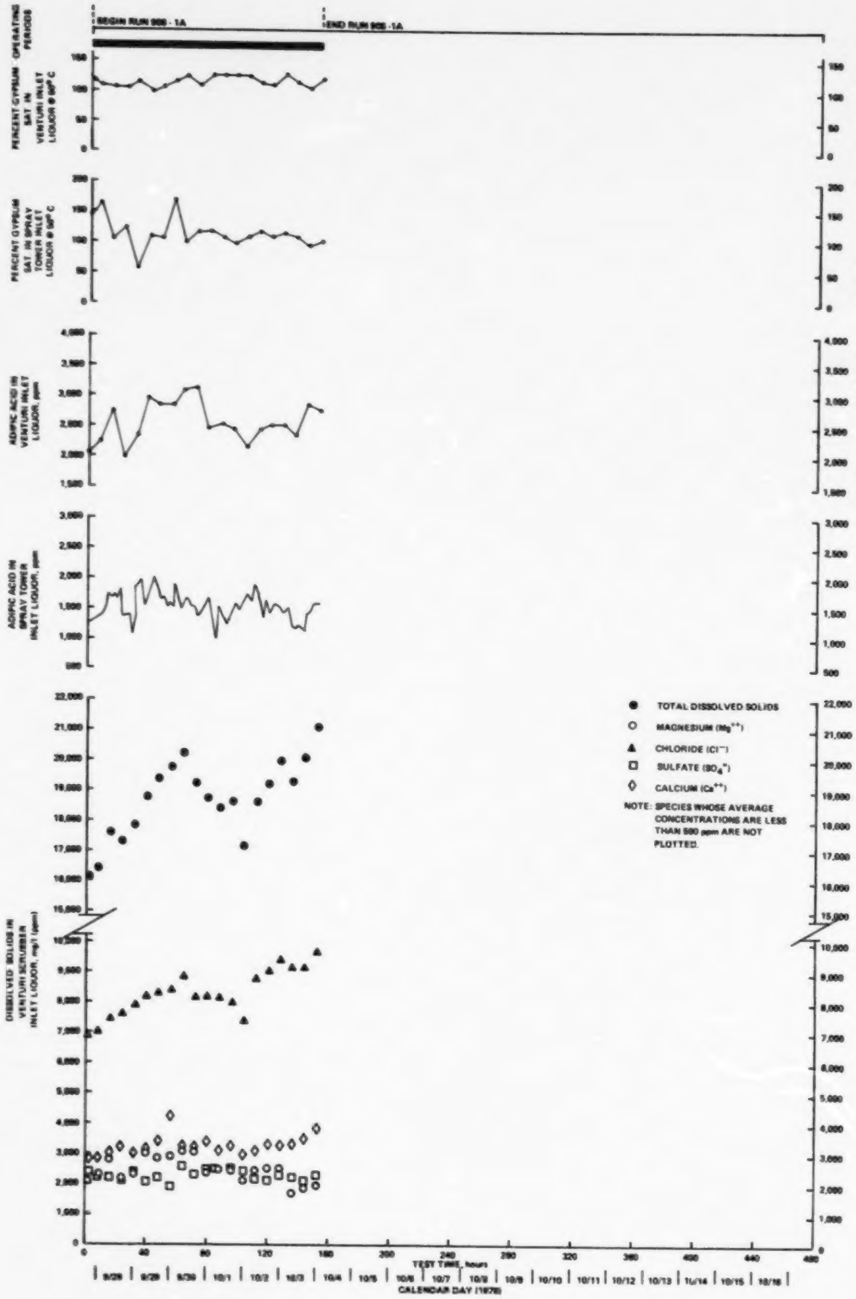


Figure F-11. Operating Data For Venturi/Spray Tower Run 906-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125 ° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.8 - 16.0 wt %
Solids Recirculated, Spray Tower Loop = 5.6 - 8.0 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.1 - 16.9 in. H_2O
Mist Elim. Pressure Drop = 0.58 - 0.64 in. H_2O
Air Flow Rate to Oxidizer = 260 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 78 - 90 wt %
Limestone Addition to Spray Tower EHT
  and to Desupersaturation Tank
Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  and to Oxidation Tank

Figure F-11 (continued). Operating Data For Venturi/Spray Tower Run 906-1A

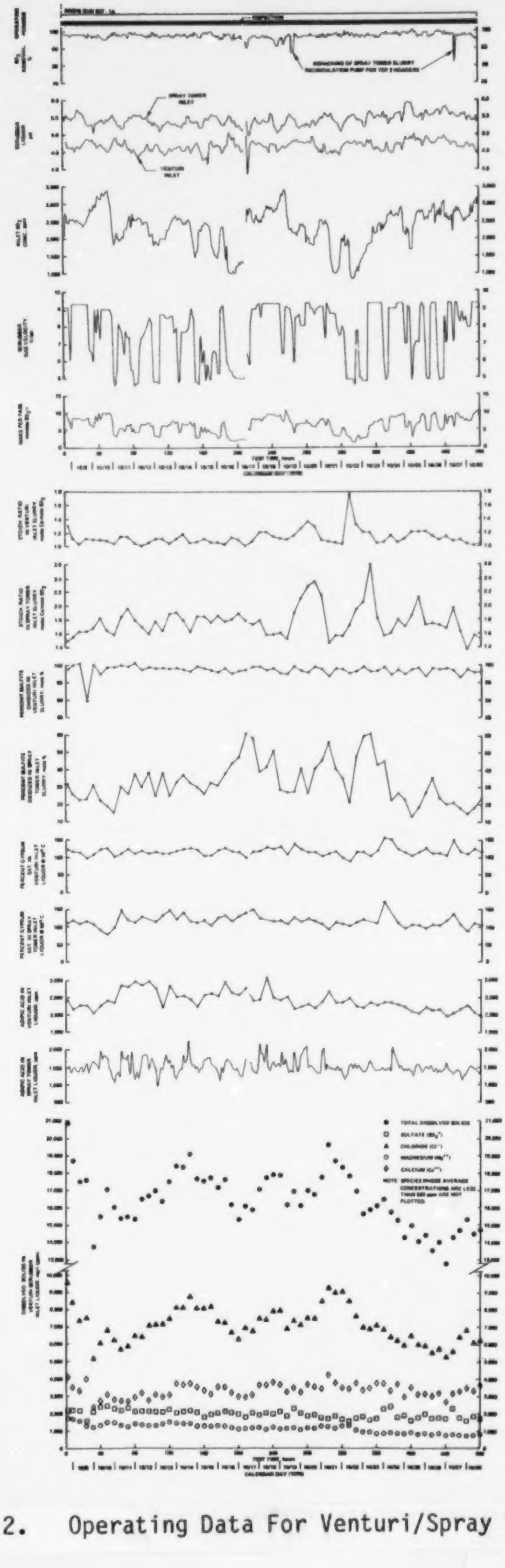
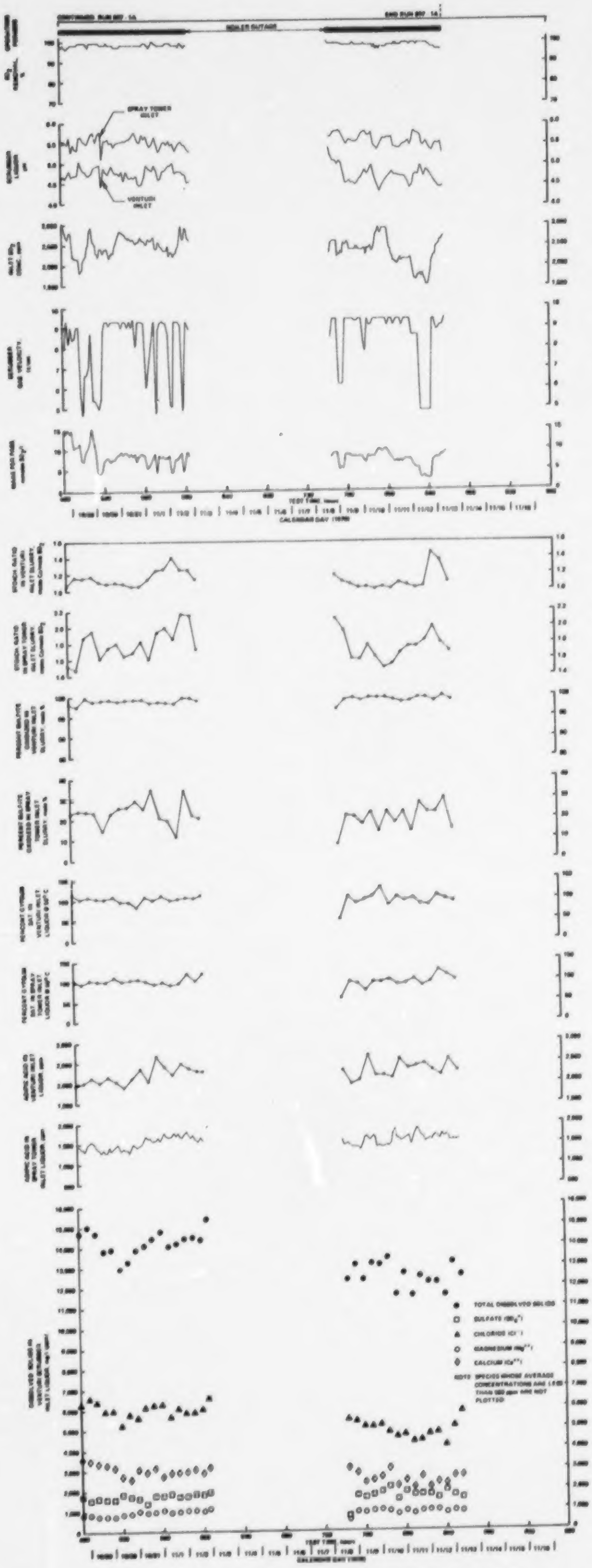


Figure F-12. Operating Data For Venturi/Spray Tower Run 907-1A



Gas Rate = 18,000 - 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.8 - 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 - 42 gal/Mcf
Spray Tower L/G = 57 - 111 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.6 - 16.2 wt %
Solids Recirculated, Spray Tower Loop = 3.8 - 8.3 wt %
Venturi Pressure Drop, = 3.0 - 9.6 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 4.6 - 16.6 in. H_2O
Mist Elim. Pressure Drop = 0.13 - 0.60 in. H_2O
Air Flow Rate to Oxidizer = 280 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82 - 92 wt %
Limestone & Dry Adipic Acid Addition to Spray Tower EHT
Separate Limestone Addition to the Desupersaturation Tank
Clarified Liquor Returned to Spray Tower EHT and
  to Oxidation Tank

Figure F-12 (continued). Operating Data for Venturi/Spray Tower Run 907-1A

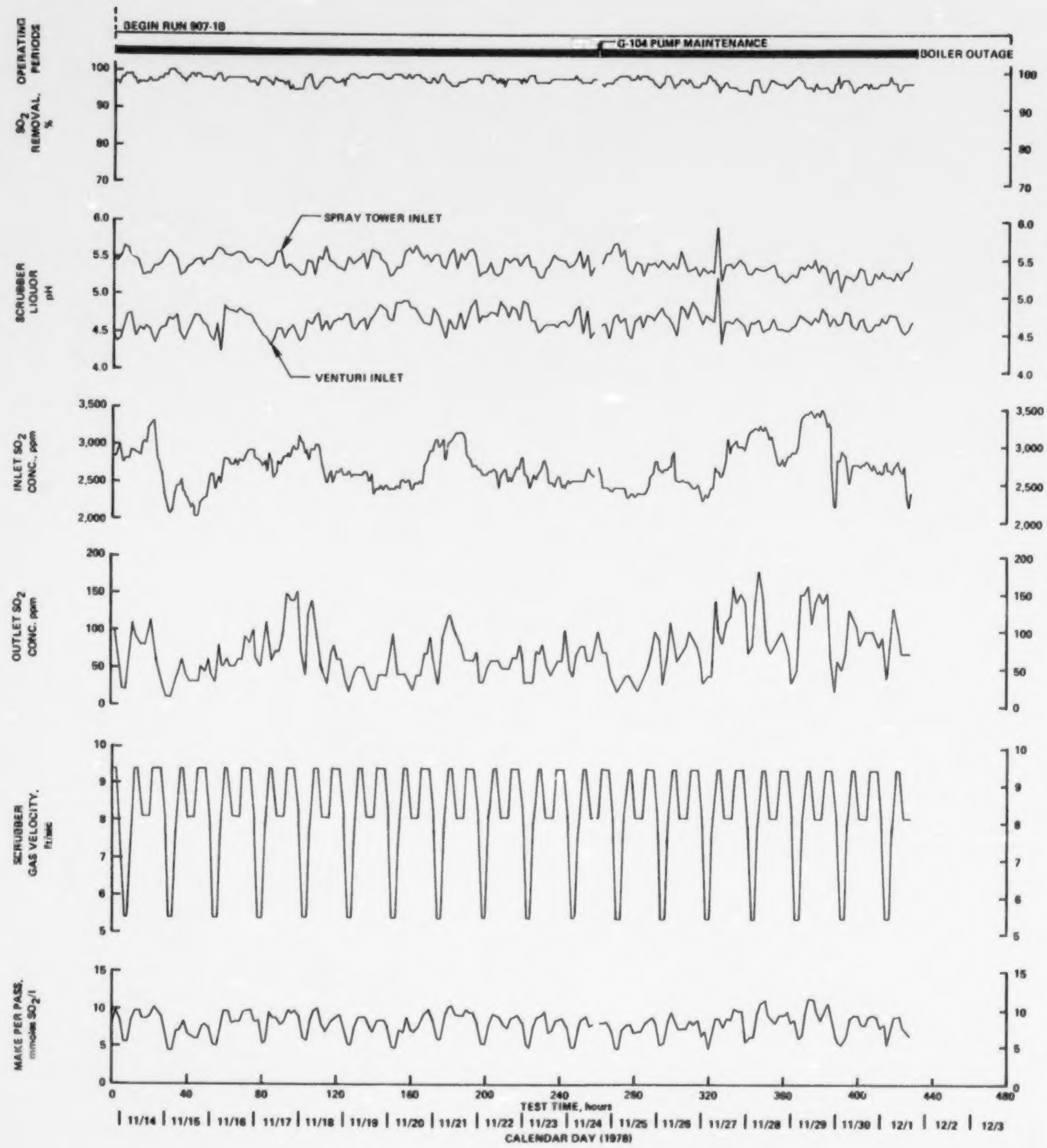


Figure F-13. Operating Data For Venturi/Spray Tower Run 907-1B

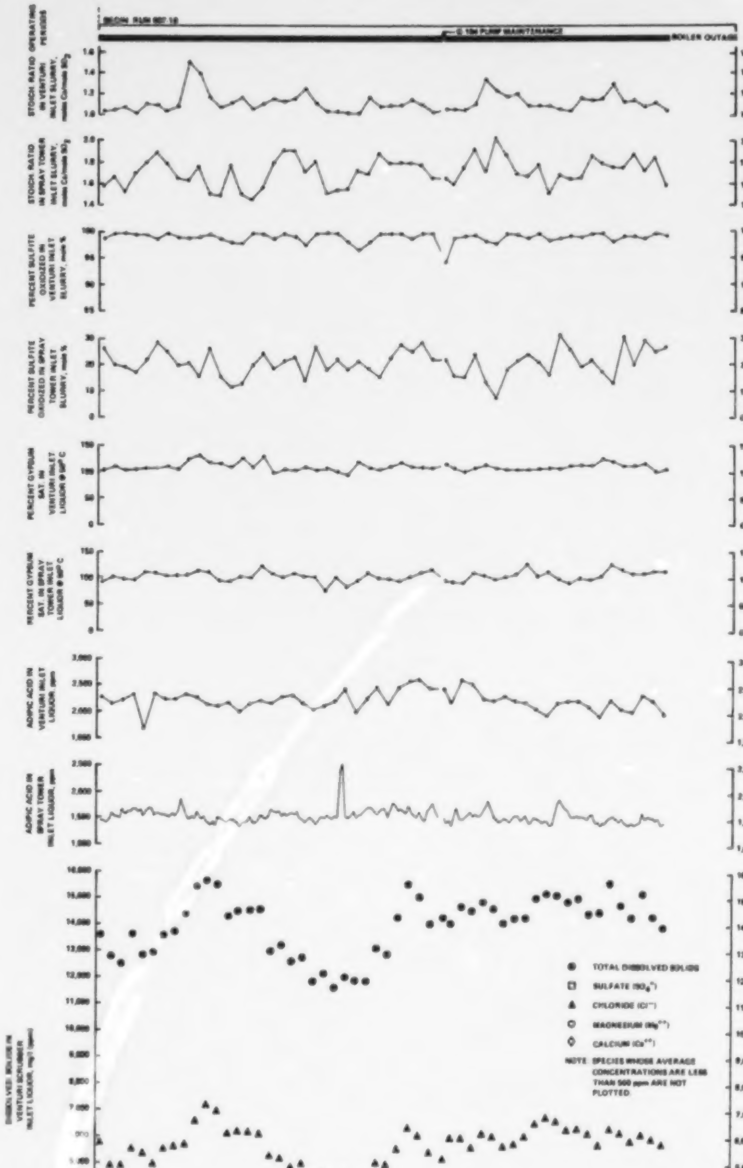


Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B

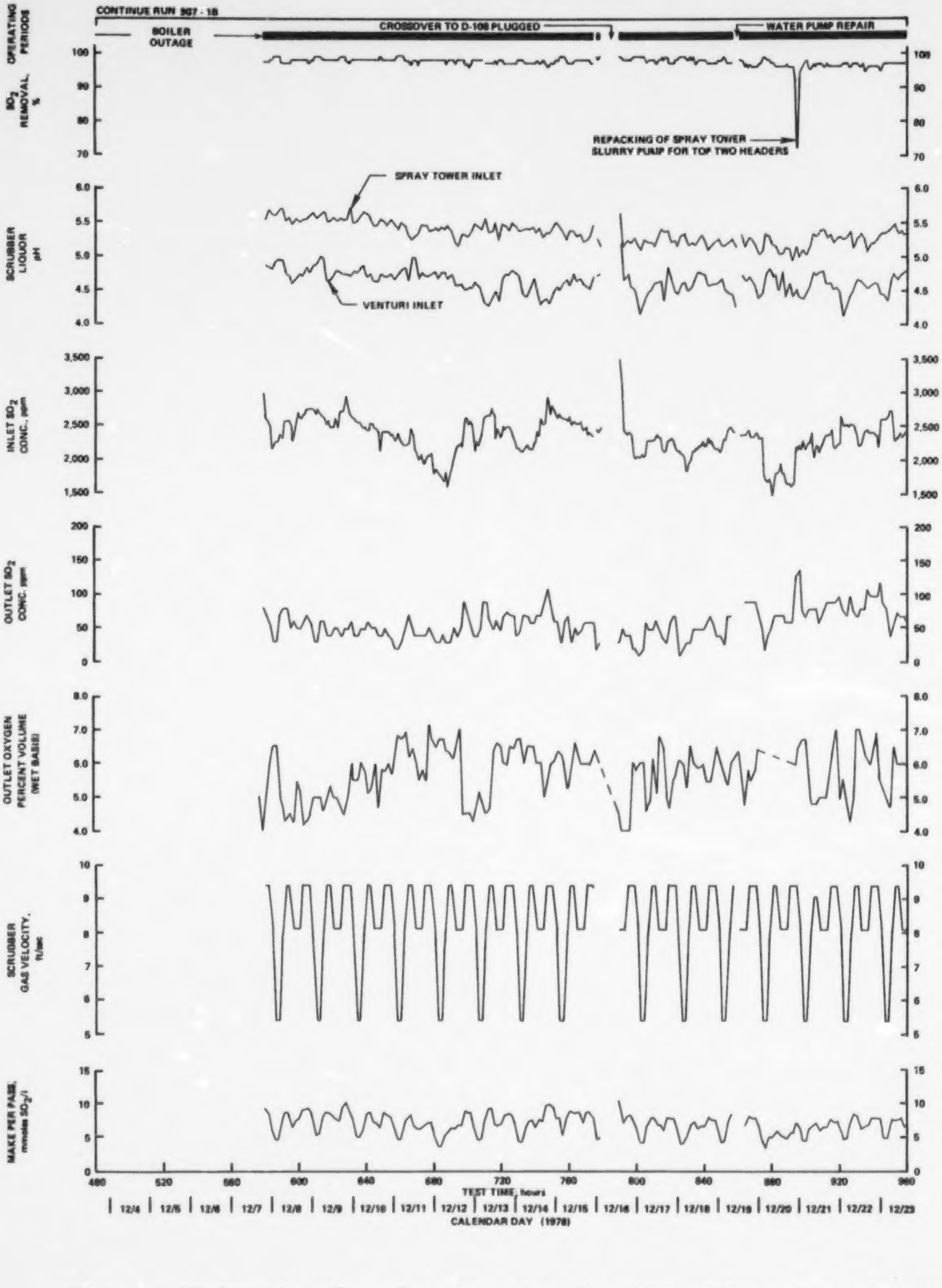


Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B

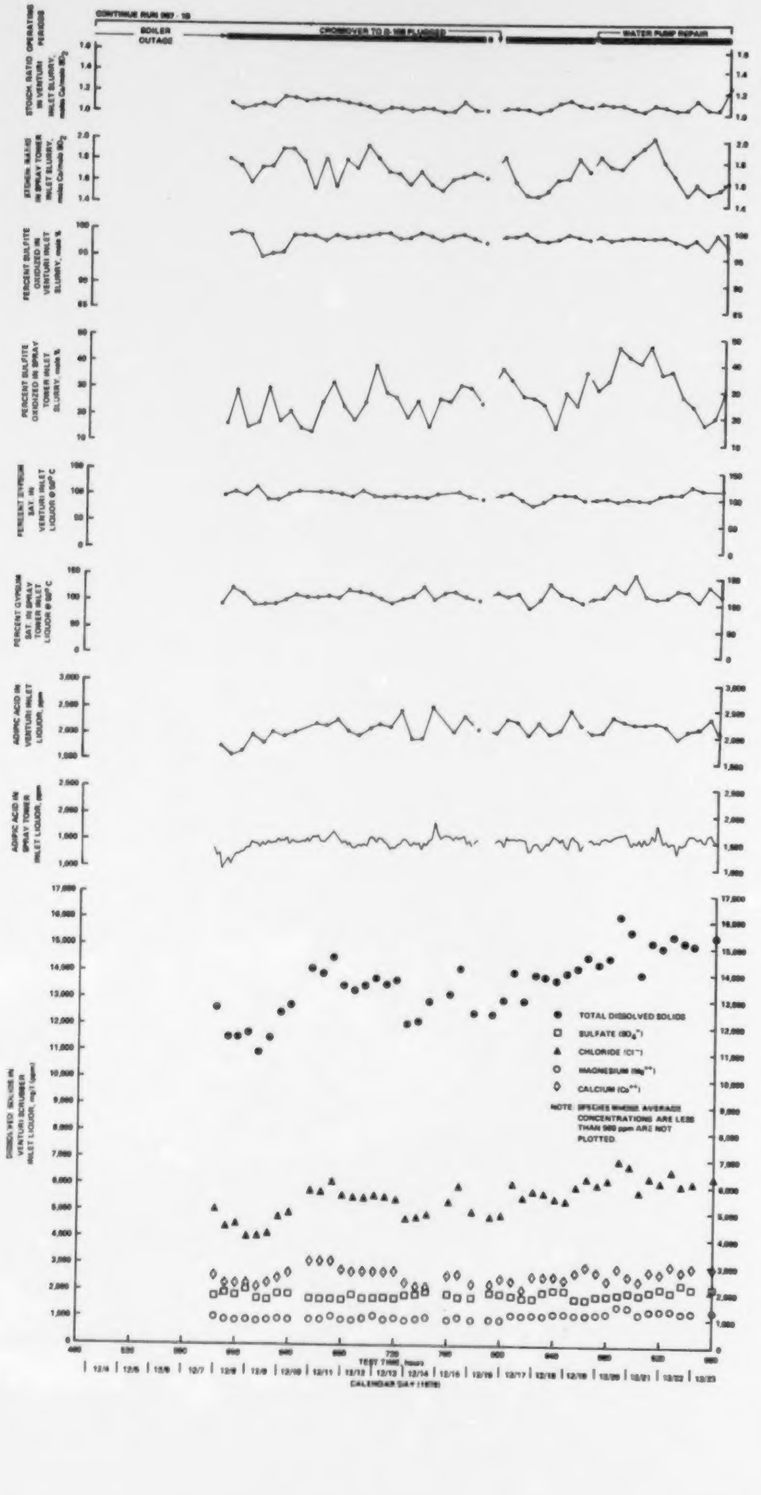


Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B

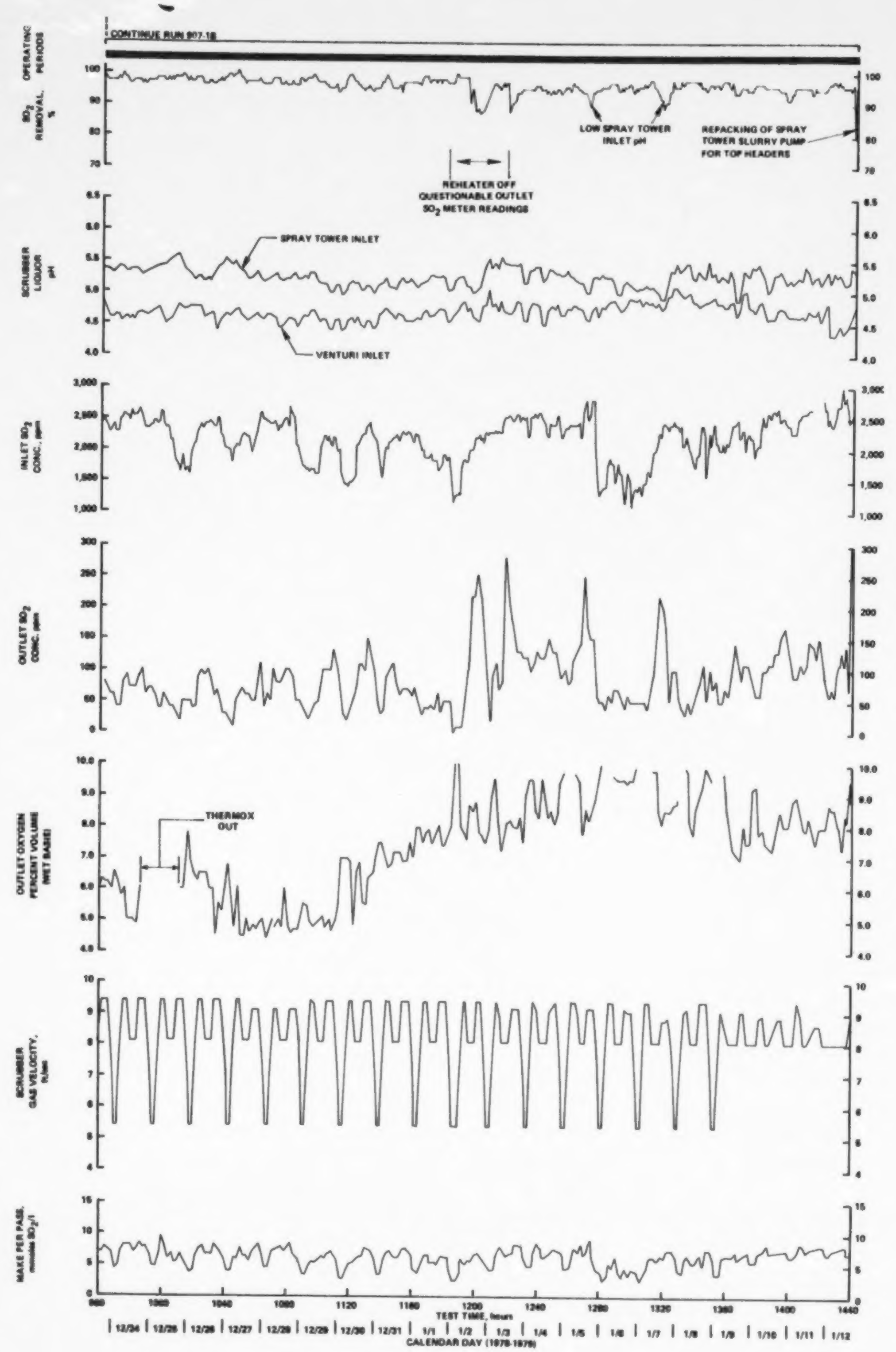


Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B

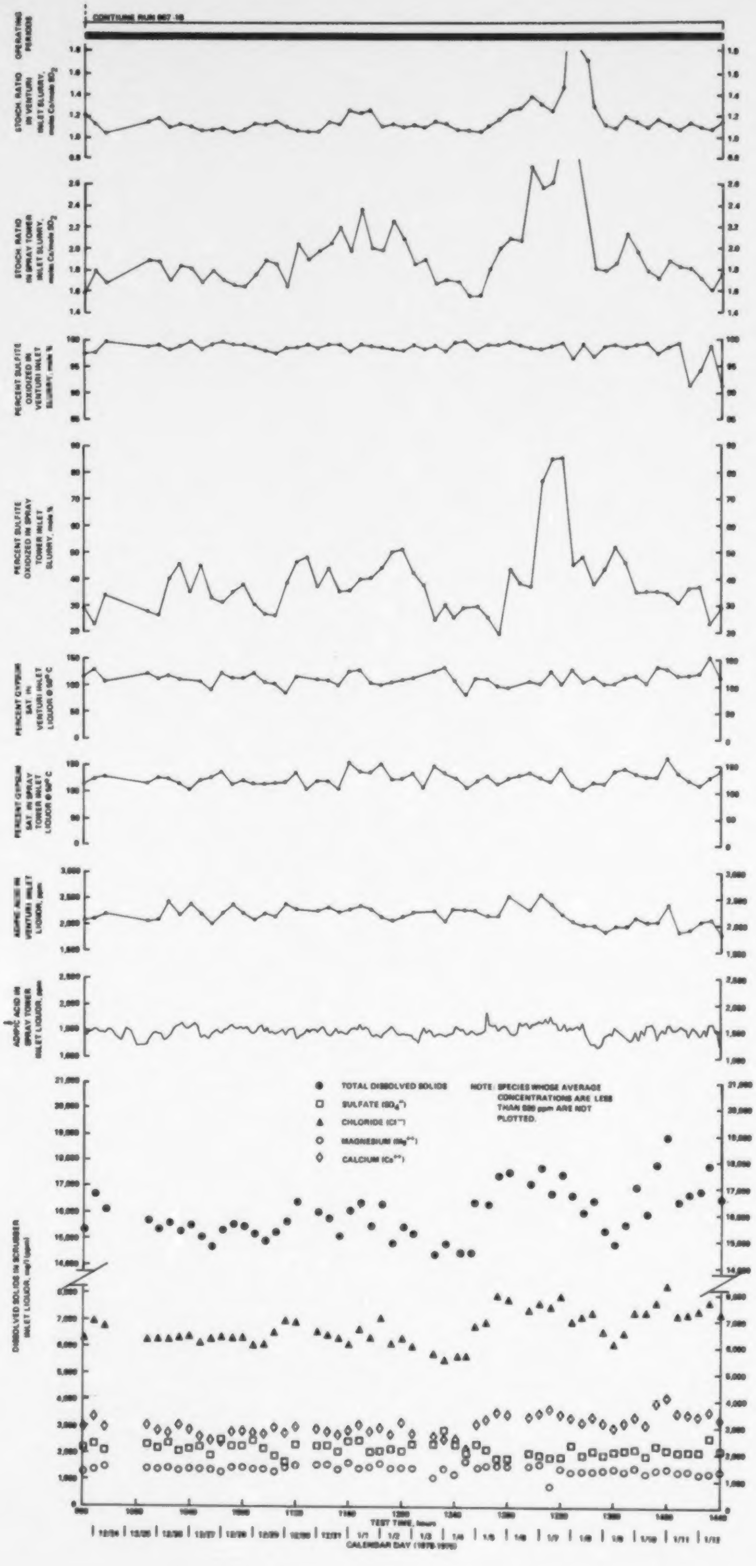


Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B

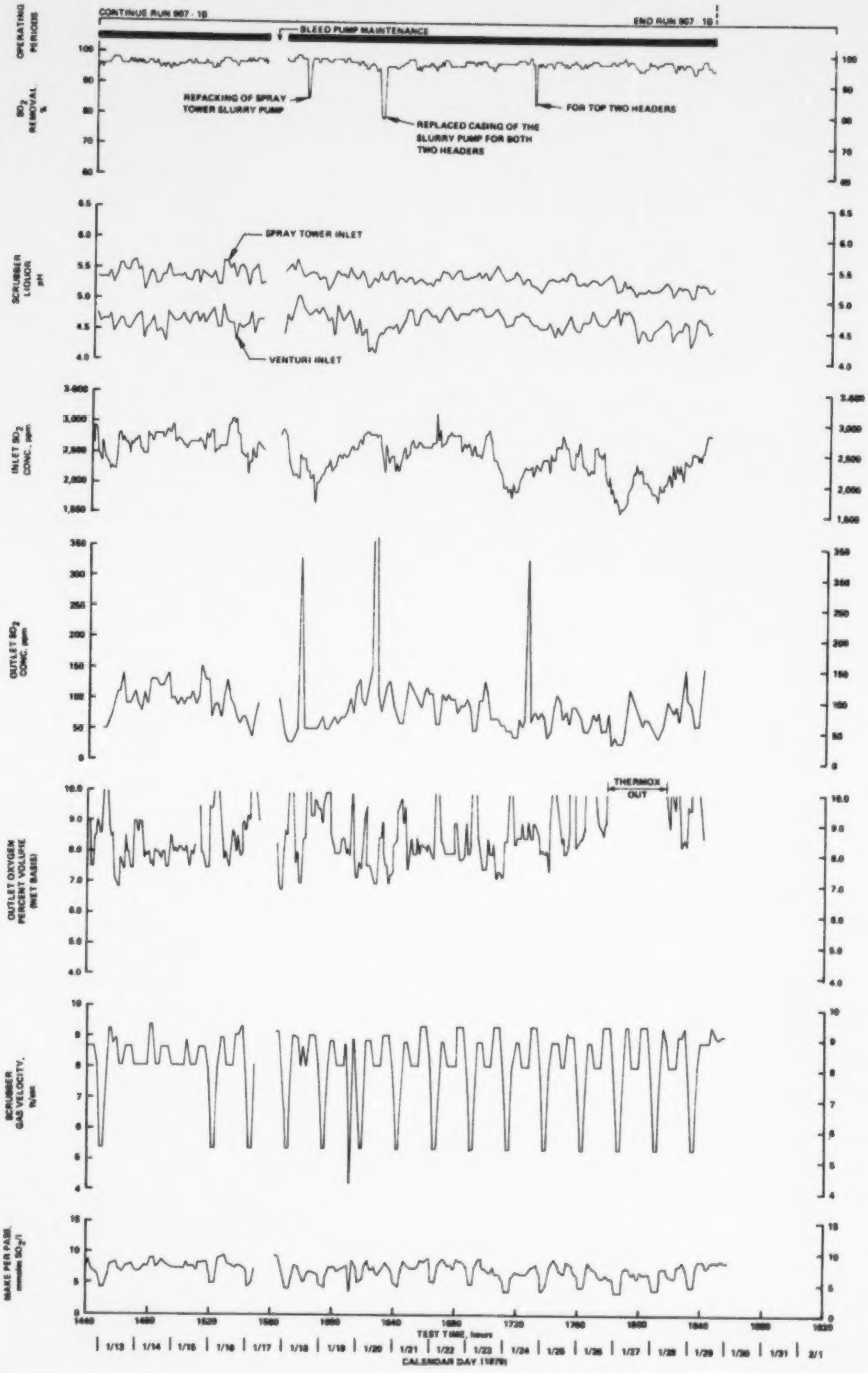
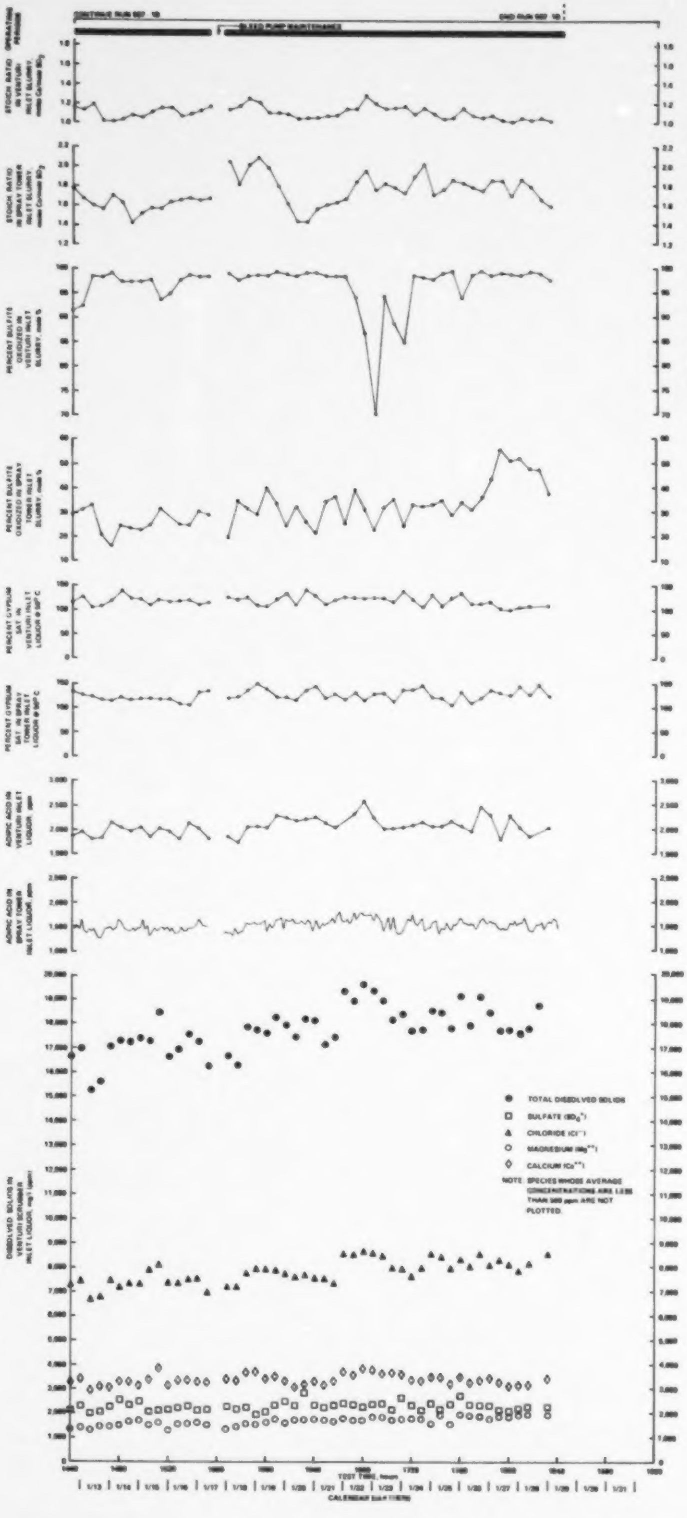


Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B



Gas Rate = 20,000 - 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 5.4 - 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 - 37 gal/Mcf
Spray Tower L/G = 57 - 100 gal/Mcf
No. of Spray Headers = 4
Residence Times:
    Spray Tower Hold Tank = 14.7 min
    Oxidation Tank = 11.3 min
    Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 11.8 - 17.8 wt %
Solids Recirculated, Spray Tower Loop = 4.4 - 7.6 wt %
Venturi Pressure Drop = 3.6 = 9.2 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
    = 5.6 - 17.2 in. H_2O
Mist Elim. Pressure Drop = 0.13 - 0.66 in. H_2O
Air Flow Rate to Oxidizer = 200 scfm
Discharge (Clarifier & Filter) Solids
    Concentration = 78 - 92 wt %
Limestone Addition to Spray Tower EHT
    and to Desupersature ion Tank (as needed)
Dry Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
    and to Oxidation Tank

Figure F-13 (continued). Operating Data For Venturi/Spray Tower Run 907-1B

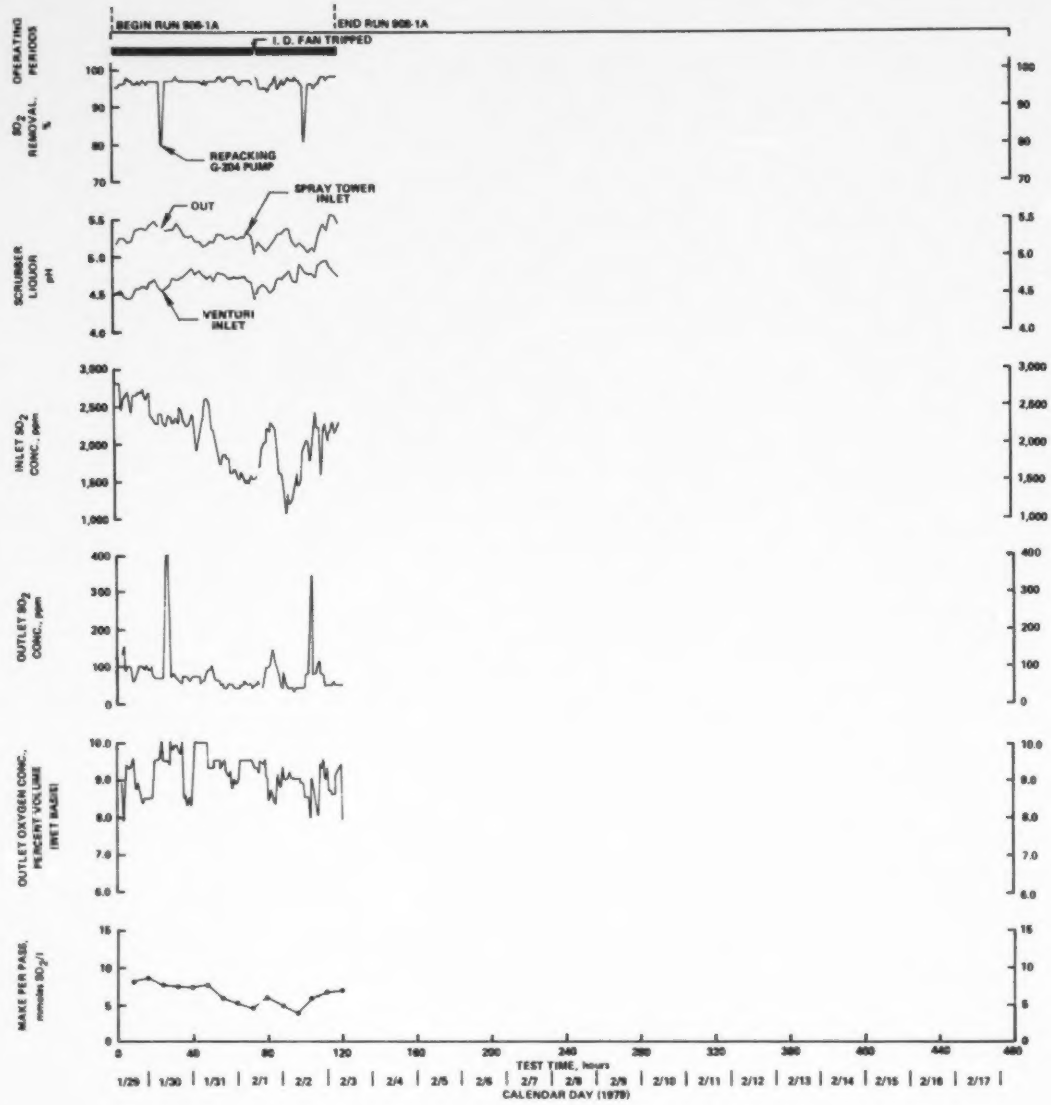
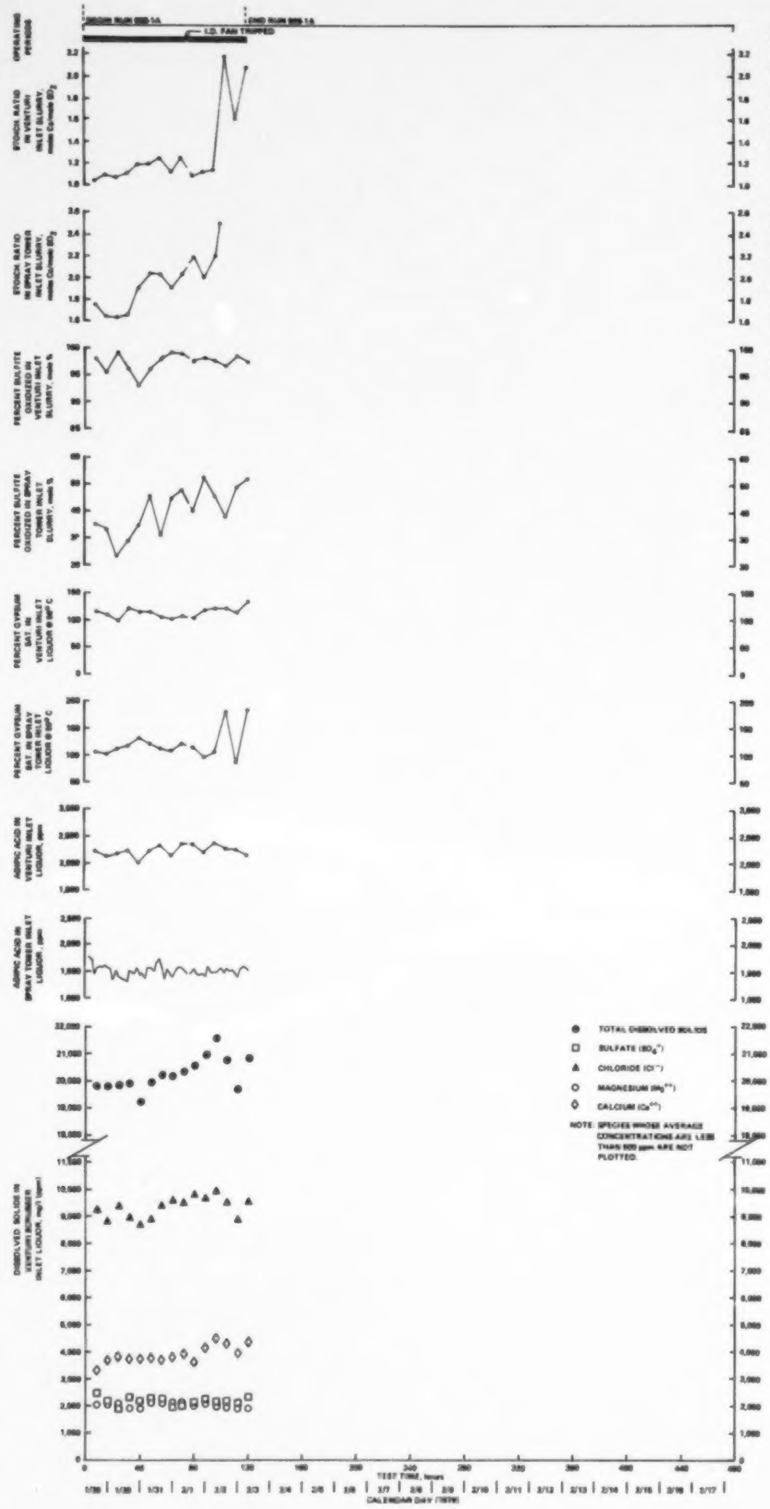


Figure F-14. Operating Data For Venturi/Spray Tower Run 908-1A



Gas Rate = 33,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.8 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 23 gal/Mcf
Spray Tower L/G = 60 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 13.8 - 15.5 wt %
Solids Recirculated, Spray Tower Loop = 5.8 - 7.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.8 - 17.4 in. H_2O
Mist Elim. Pressure Drop = 0.50 - 0.67 in. H_2O
Air Flow Rate to Oxidizer = 260 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 86 wt %
Limestone and Adipic Acid Addition to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT
  and Oxidation Tank

Figure F-14 (continued). Operating Data For Venturi/Spray Tower Run 908-1A

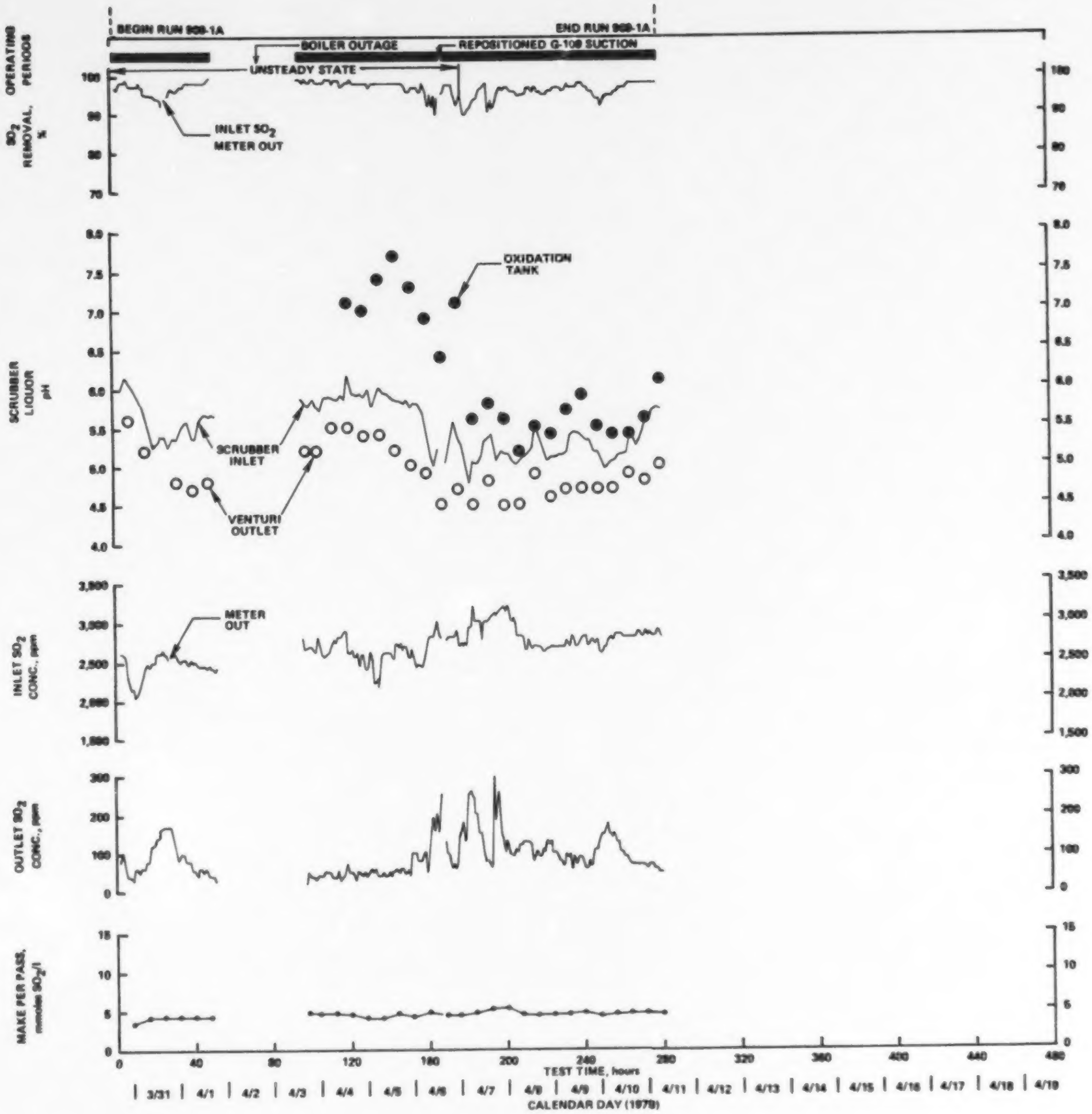
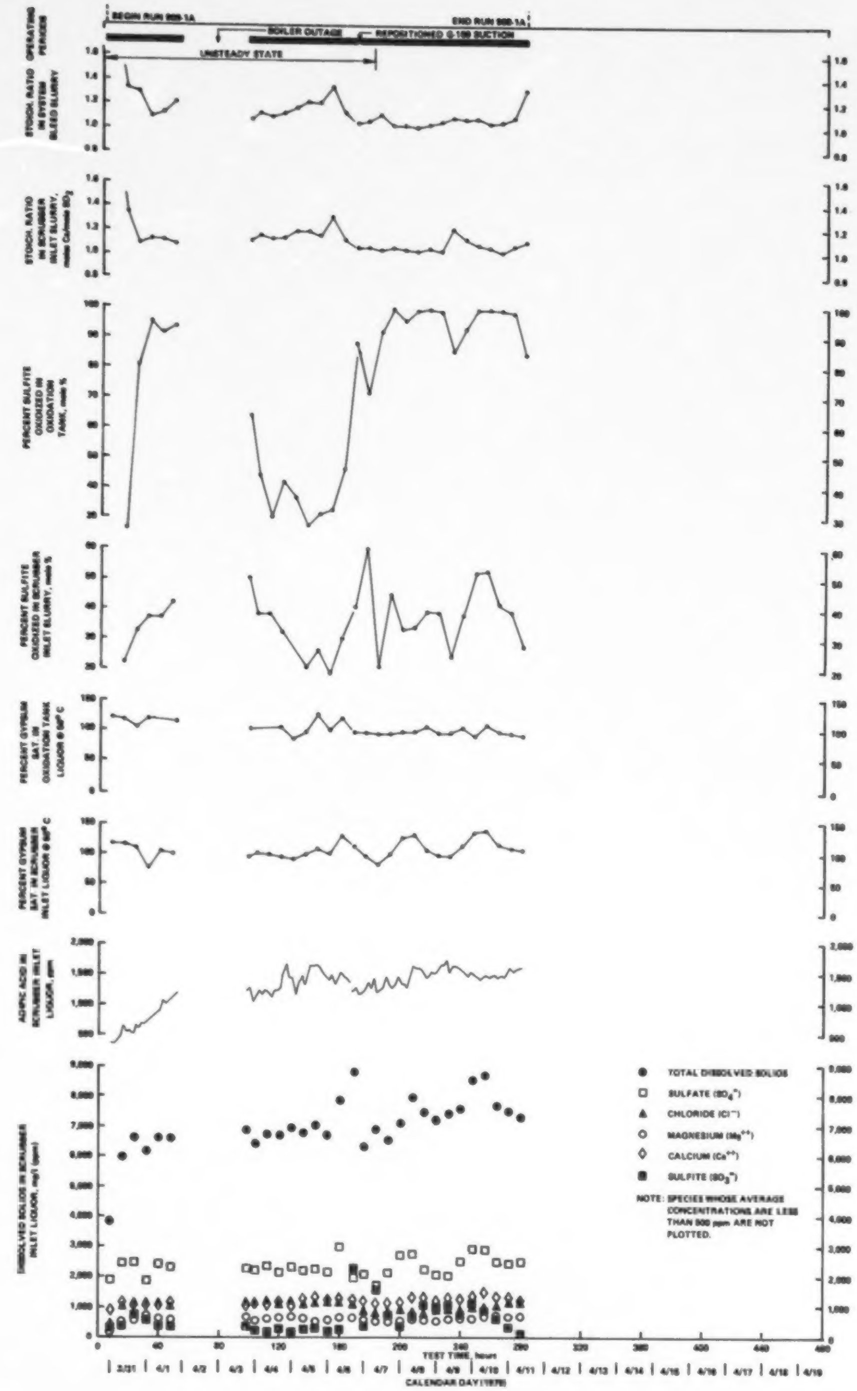


Figure F-15. Operating Data For Venturi/Spray Tower Run 909-1A



Gas Rate = 18,000 acfm @ 300°F
Spray Tower Gas Velocty = 4.8 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 42 gal/Mcf
Spray Tower L/G = 111 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.8 min
Oxidation Tank Level = 18 min
Scrubber Solids Recirculated = 10.4 - 13.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 9.0 - 10.7 in. H_2O
Mist Elim. Pressure Drop = 0.13 - 0.25 in. H_2O
Air Flow Rate to Oxidizer = 120 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 78 - 91 wt %
Limestone and Adipic Acid Addition to the EHT
Clarified Liquor Returned to the EHT

Figure F-15 (continued). Operating Data For Venturi/Spray Tower Run 909-1A

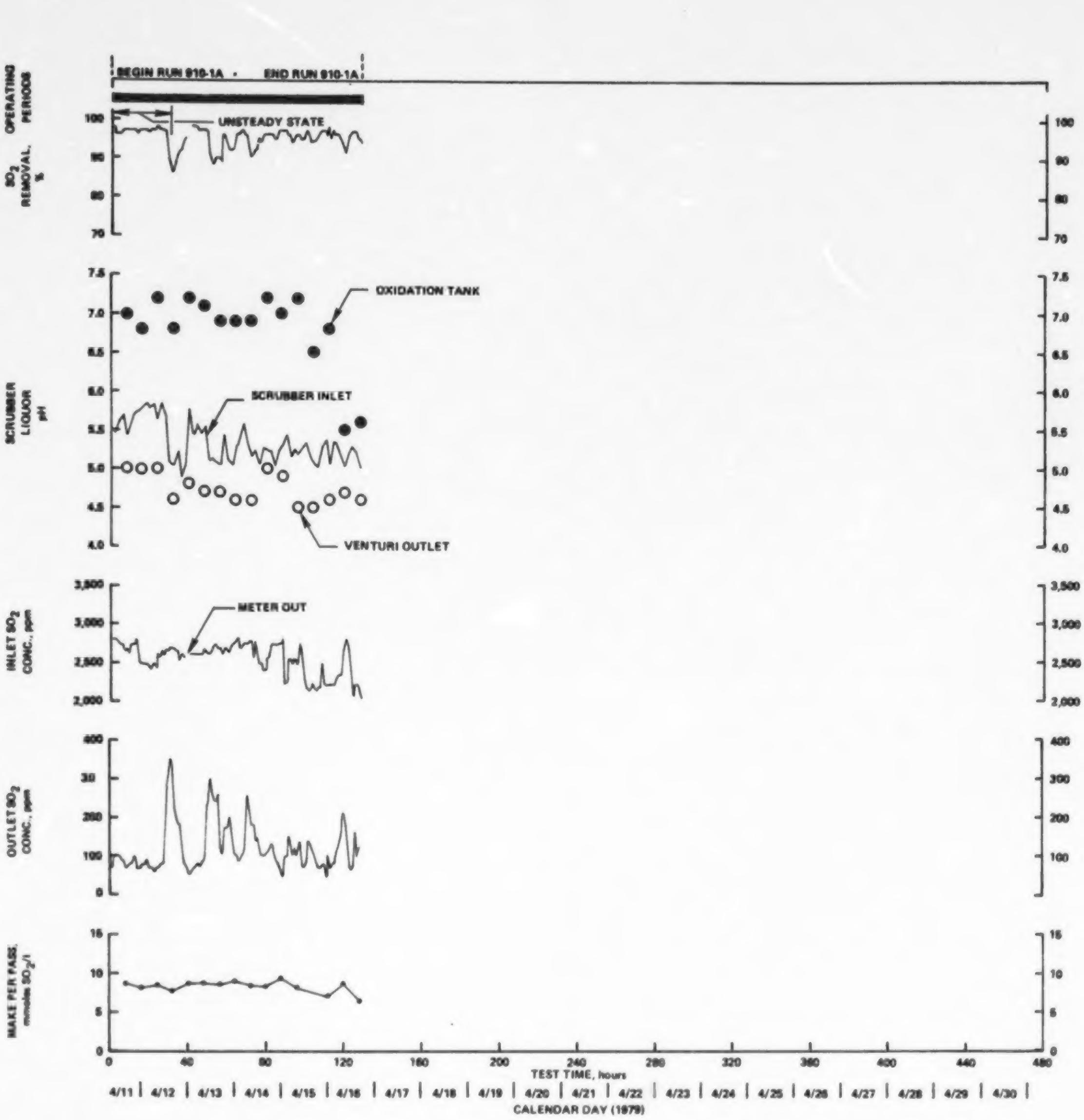
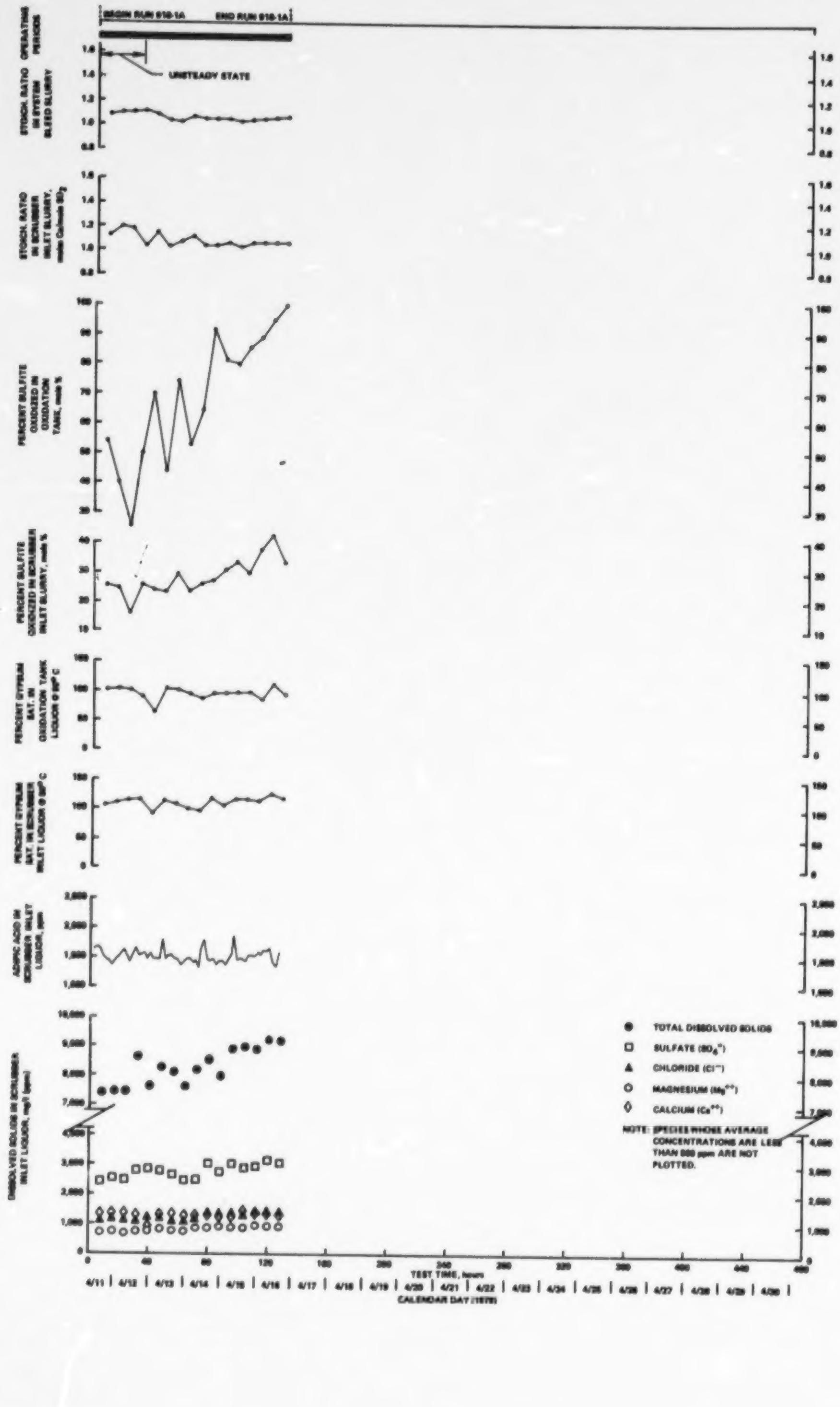


Figure F-16. Operating Data For Venturi/Spray Tower Run 910-1A



Gas Rate = 35,000 acfm @ 300^{0}F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125^0 F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.8 min
Oxidation Tank Level = 18 min
Scrubber Solids Recirculated = 14.1 - 16.5 wt %
Venturi Pressure Drop = 9 in H_2O
Total Pressure Drop, Excl. Mist Elim.
= 12.5 - 15.8 in. H_2O
Mist Elim. Pressure Drop = 0.54 - 0.78 in. H_2O
Air Flow Rate to Oxidizer = 240 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 63 - 87 wt %
Limestone and Adipic Acid Addition to the EHT
Clarified Liquor Returned to the EHT

Figure F-16 (continued). Operating Data For Venturi/Spray Tower Run 910-1A

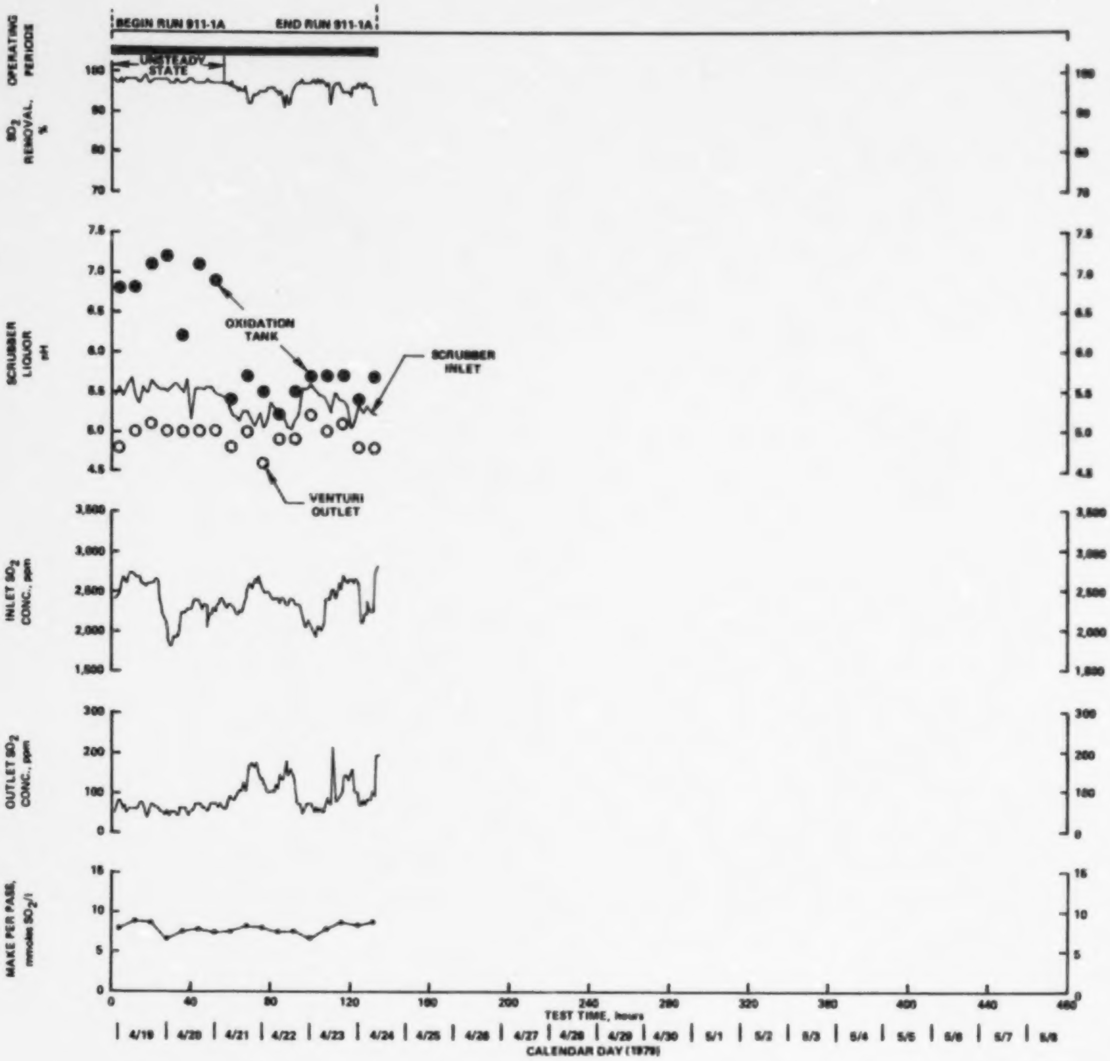
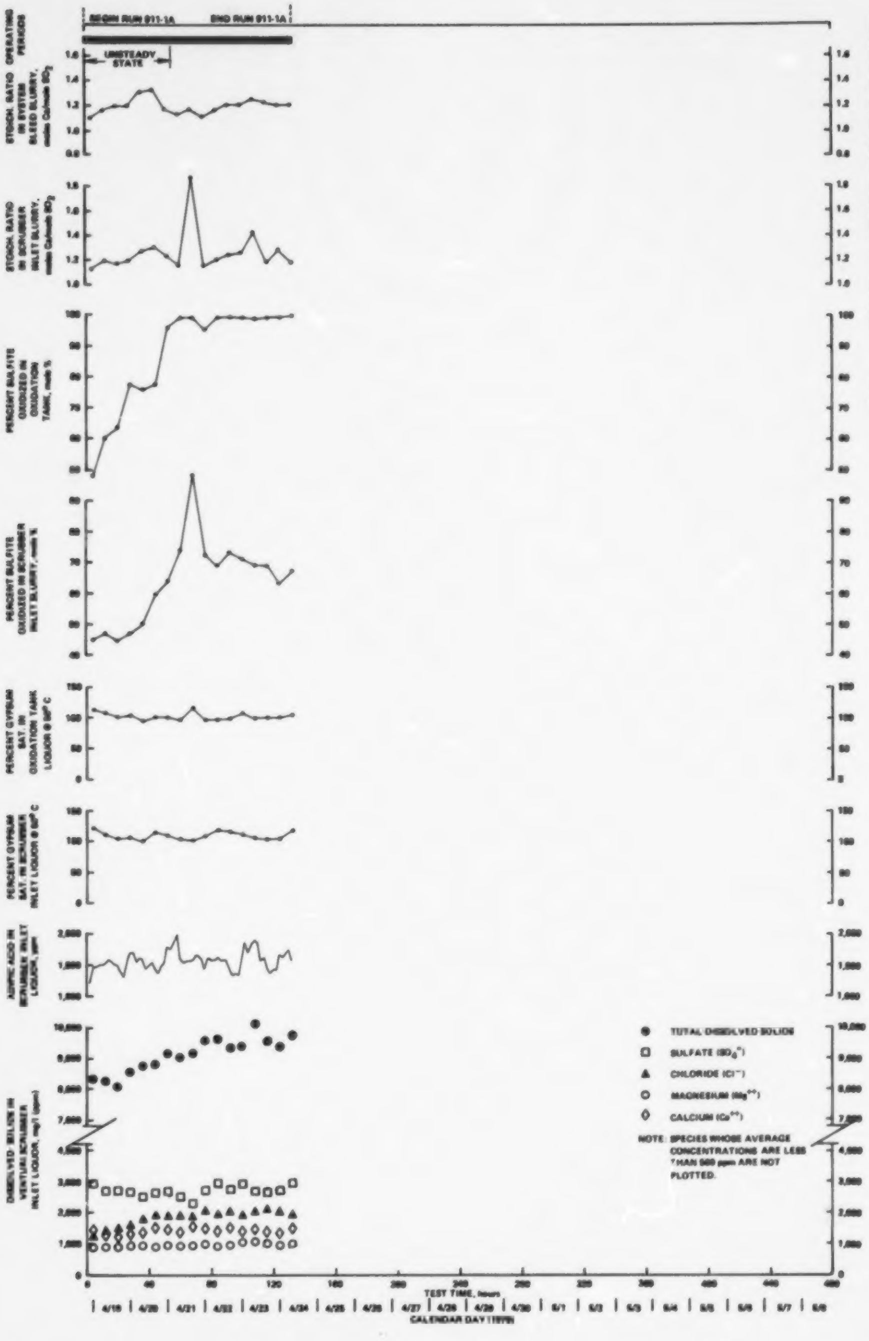


Figure F-17. Operating Data For Venturi/Spray Tower Run 911-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.8 min
Oxidation Tank Level = 18 ft
Scrubber Solids Recirculated = 13.9 - 16.1 wt %
Venturi Pressure Drop = 7.5 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
= 13.3 - 15.4 in. H_2O
Mist Elim. Pressure Drop = 0.59 - 0.64 in. H_2O
Air Flow Rate to Oxidizer = 240 scfm
Discharge (Clarifier & Filter) Solids
Concentration = 80 - 88 wt %
Limestone and Adipic Acid Addition to the EHT
Clarified Liquor Returned to the EHT
Recirculated Liquor from Oxidation Tank to
EHT = 60 gpm

Figure F-17 (continued). Operating Data For Venturi/Spray Tower Run 911-1A

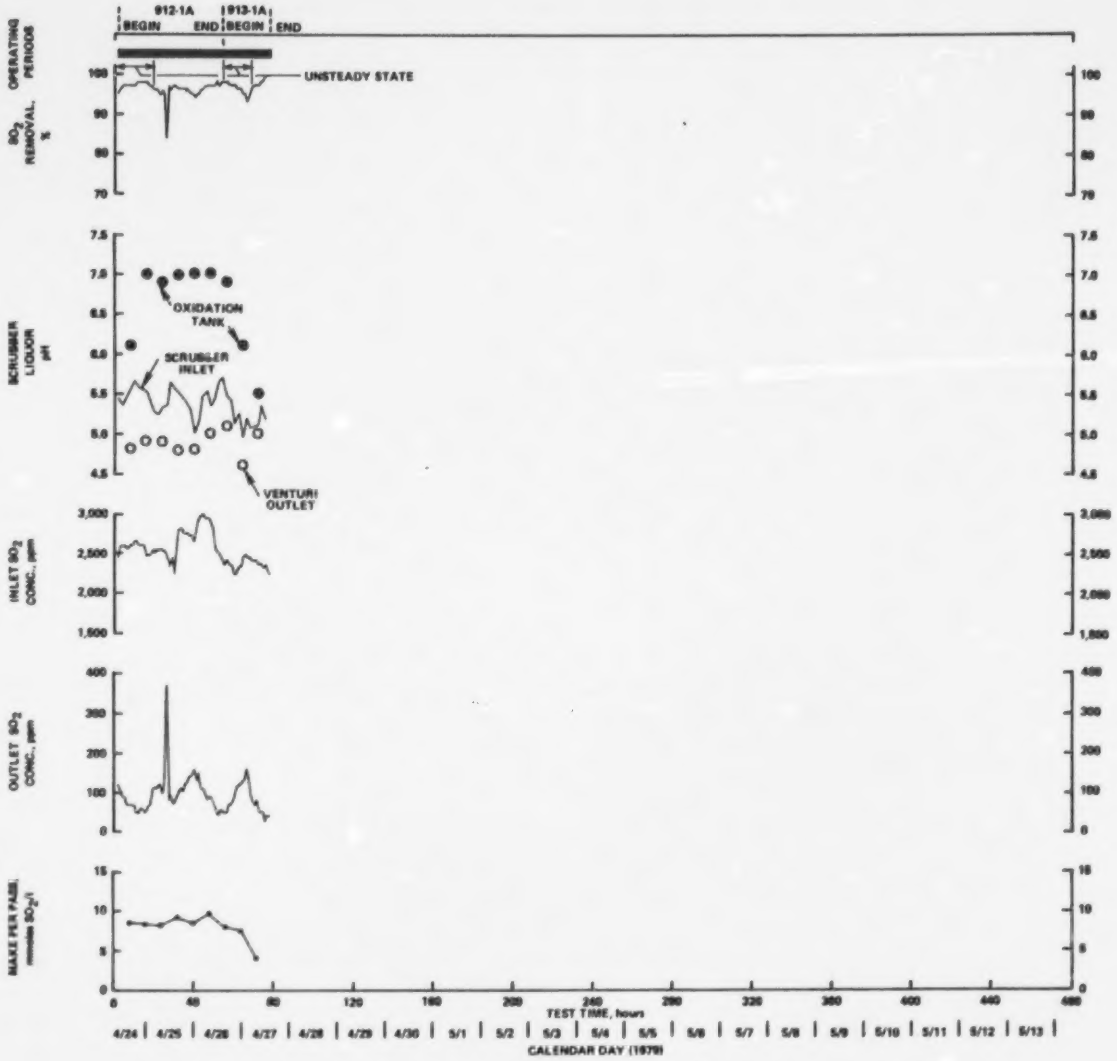
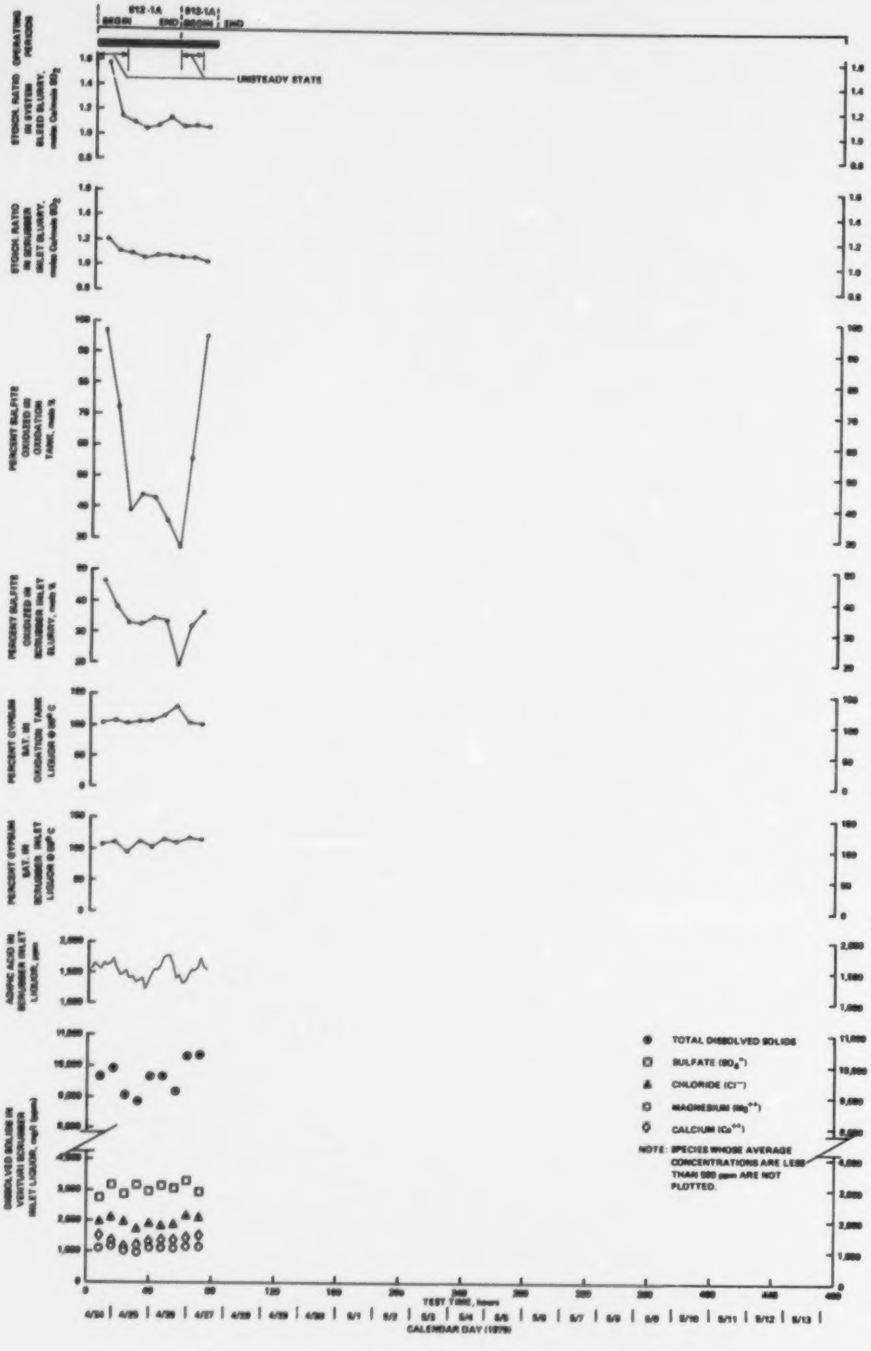


Figure F-18. Operating Data For Venturi/Spray Tower Runs 912-1A And 913-1A



912-1A

Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.8 min
Oxidation Tank Level = 18 ft
Scrubber Solids Recirculated = 13.5 - 14.5 wt %
Venturi Pressure Drop = 7.5 in. H_2O
Total Pressure Drop, Excl. Mist Elim. = 11.8 - 14.7 in. H_2O
Mist Elim. Pressure Drop = 0.47 - 0.62 in. H_2O
Air Flow Rate to Oxidizer = 350 scfm
Discharge (Clarifier & Filter) Solids Concentration = 57 - 68 wt %
Limestone and Adipic Acid Addition to the EHT
Clarified Liquor Returned to the EHT

913-1A

Gas Rate = 18,000 acfm @ 300° F
Spray Tower Gas Velocity = 4.8 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 42 gal/Mcf
Spray Tower L/G = 111 gal/Mcf
No. of Spray Headers = 4
Effluent Hold Tank Residence Time = 11.8 min
Oxidation Tank Level = 18 ft
Scrubber Solids Recirculated = 13.5 wt %
Venturi Pressure Drop = 8 in. H_2O
Total Pressure Drop, Excl. Mist Elim. = 8.9 - 9.1 in. H_2O
Mist Elim. Pressure Drop = 0.16 - 0.18 in. H_2O
Air Flow Rate to Oxidizer = 120 scfm
Discharge (Clarifier & Filter) Solids Concentration = 79 wt %
Limestone and Adipic Acid Addition to the EHT
Clarified Liquor Returned to the EHT

Figure F-18 (continued). Operating Data For Venturi/Spray Tower Runs 912-1A And 913-1A

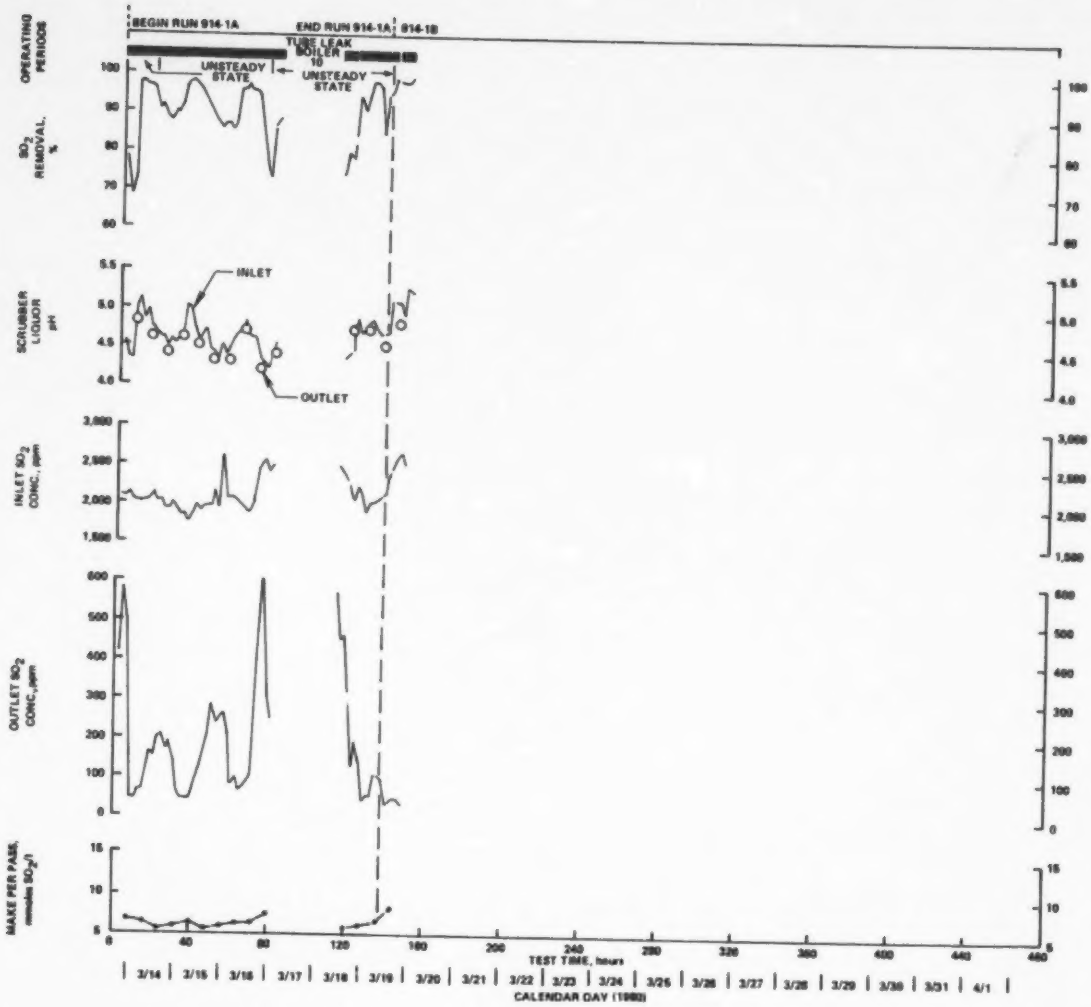
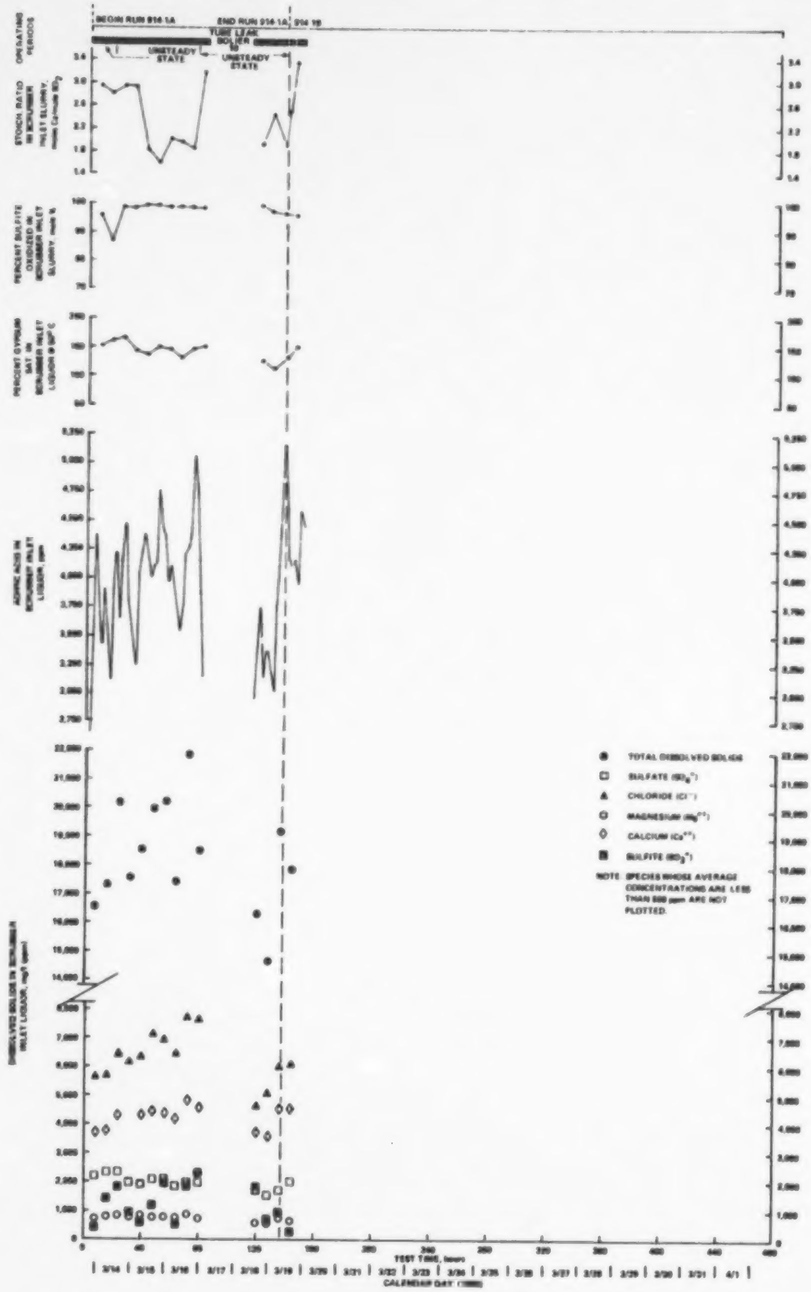


Figure F-19. Operating Data For Venturi/Spray Tower Run 914-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of Oxidation Tank = 2.9 min.
Percent Solids Recirculated = 14.7-17.1 % wt
Discharge (Clarifier and Centrifuge) = 78-80 % wt
Total Pressure Drop' Excluding Mist Elim. = 14.6-17.3 in. H_2O
Venturi Pressure Drop = 9 in. H_2O
Mist Elim. Pressure Drop = 0.26-0.36 in. H_2O
Air Flow to Oxidizer = 200 scfm
Oxidation Tank Agitator Speed = 56 rpm
Limestone Addition to Oxidation Tank
Adipic Acid Dry Fed to Oxidation Tank
Clarified Liquor Returned to Oxidation Tank

Figure F-19 (continued). Operating Data For Venturi/Spray Tower Run 914-1A

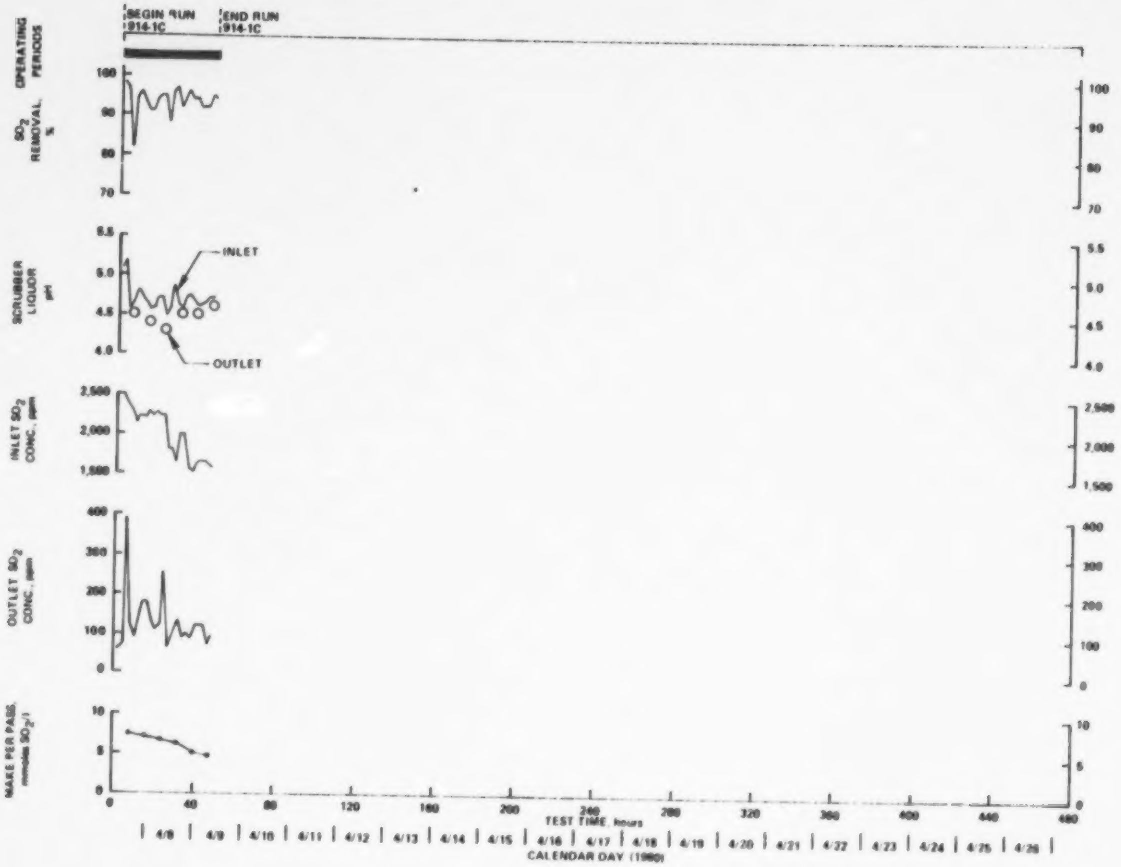
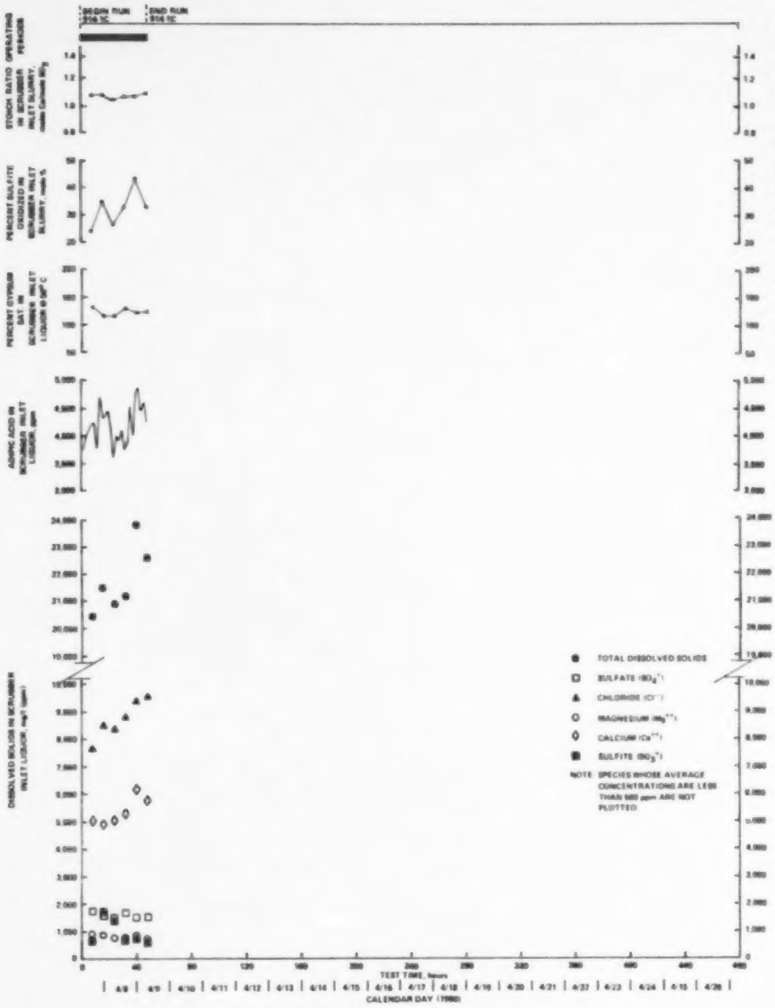


Figure F-20. Operating Data For Venturi/Spray Tower Run 914-1C



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of Oxidation Tank = 2.9 min.
Percent Solids Recirculated = 13.9-15.9 % wt
Discharge (Clarifier and Centrifuge) = 62-68 % wt
Total Pressure Drop, Excluding Mist Elim. =15.2-16.2 in. H_2O
Venturi Pressure Drop = 8.6-9.7 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.34 in. H_2O
Air Flow to Oxidizer = none
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to Oxidation Tank
Adipic Acid Dry Fed to Oxidation Tank
Clarified Liquor Returned to Oxidation Tank

Figure F-20 (continued). Operating Data For Venturi/Spray Tower Run 914-1C

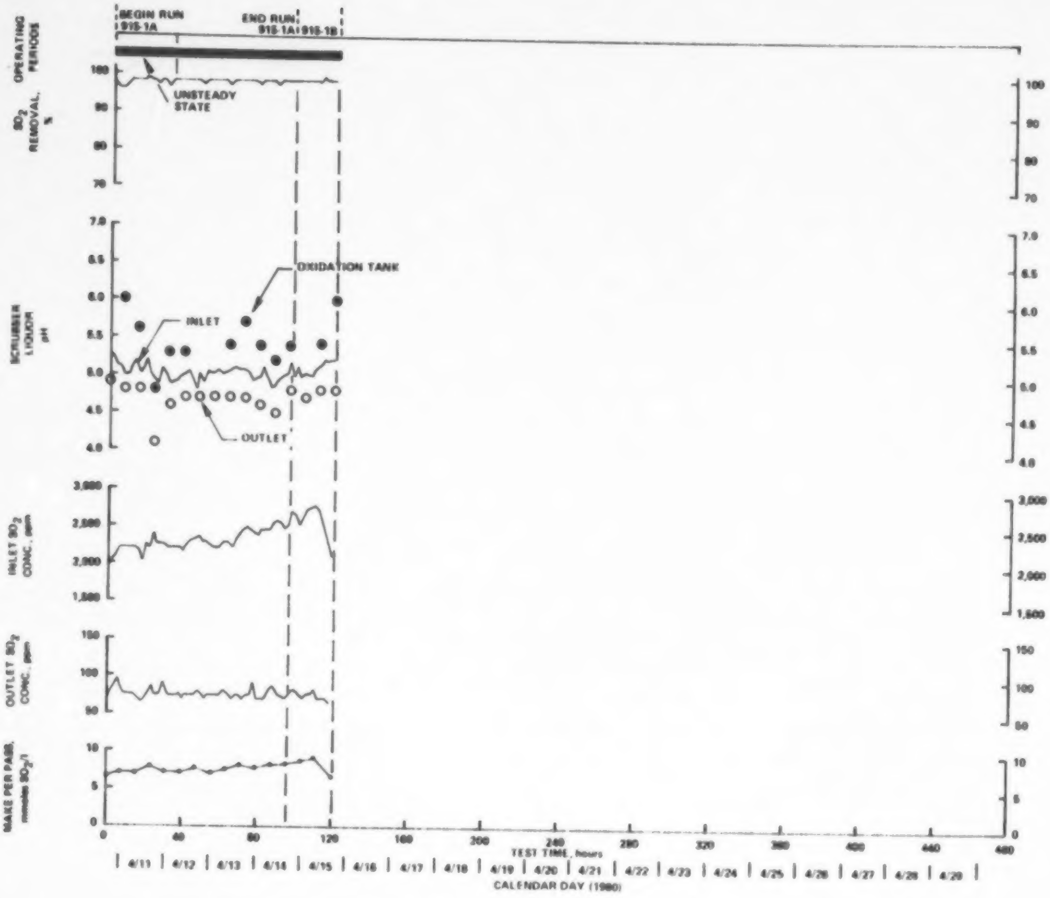
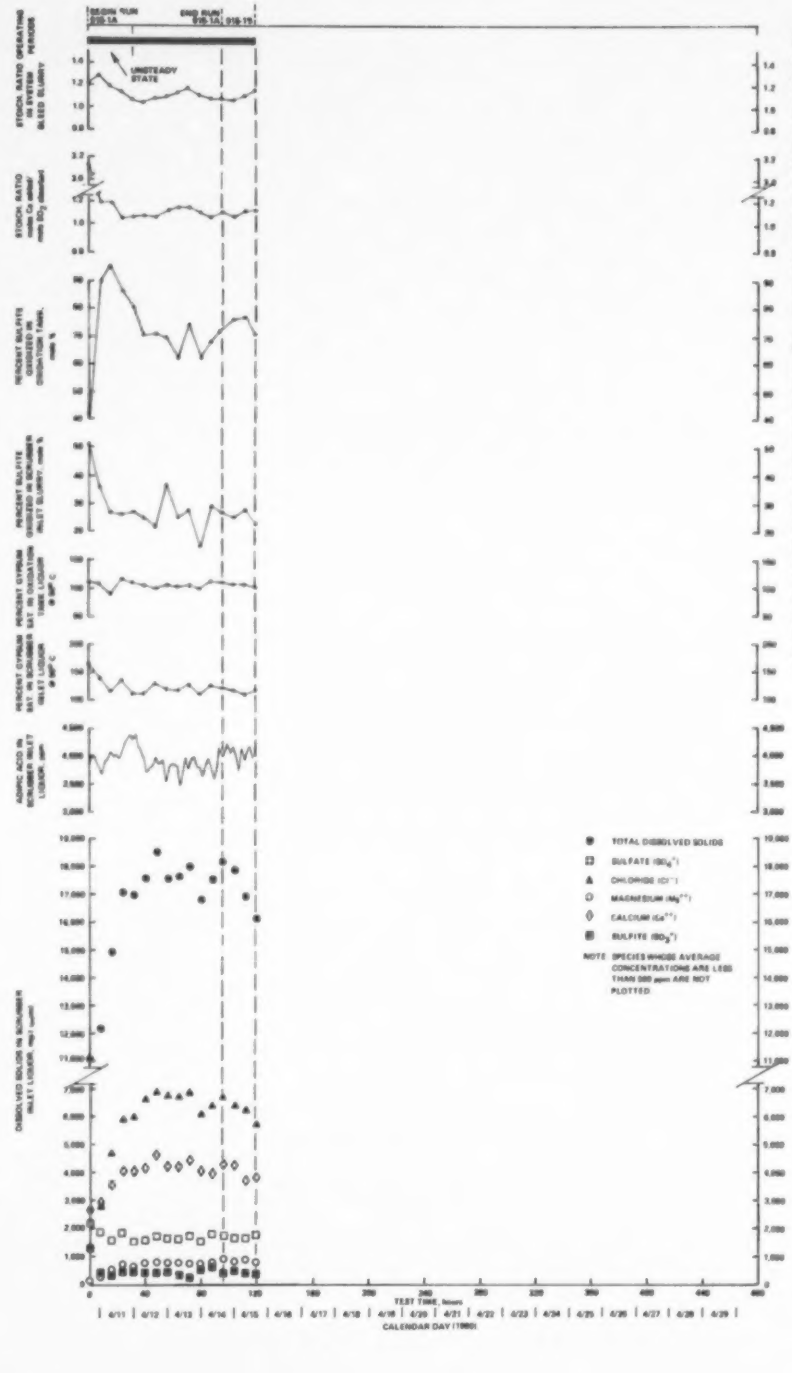


Figure F-21. Operating Data For Venturi/Spray Tower Runs 915-1A And 915-1B

F



915-1A

Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 9.1 min.
Oxidation Tank Level = 17 ft.
Percent Solids Recirculated = 14.4-16.0 % wt
Discharge (Clarifier and Centrifuge) = 67-72 % wt
Air Rate to Oxidizer = 200 scfm
Total Pressure Drop, Excluding Mist Elim. = 15.5-16.3 in. H_2O
Venturi Pressure Drop = 8.6-9.8 in. H_2O
Mist Elim. Pressure Drop = 0.29-0.34 in. H_2O

915-1B

Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 9.1 min.
Oxidation Tank Level = 17 ft.
Percent Solids Recirculated = 15.2-15.8 % wt
Discharge (Clarifier and Centrifuge) = 79-80 % wt
Air Rate to Oxidizer = 300 scfm
Total Pressure Drop, Excluding Mist Elim. = 16.2-16.8 in. H_2O
Venturi Pressure Drop = 8.6-9.1 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.33 in. H_2O
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-21 (continued). Operating Data For Venturi/Spray Tower Runs 915-1A And 915-1B

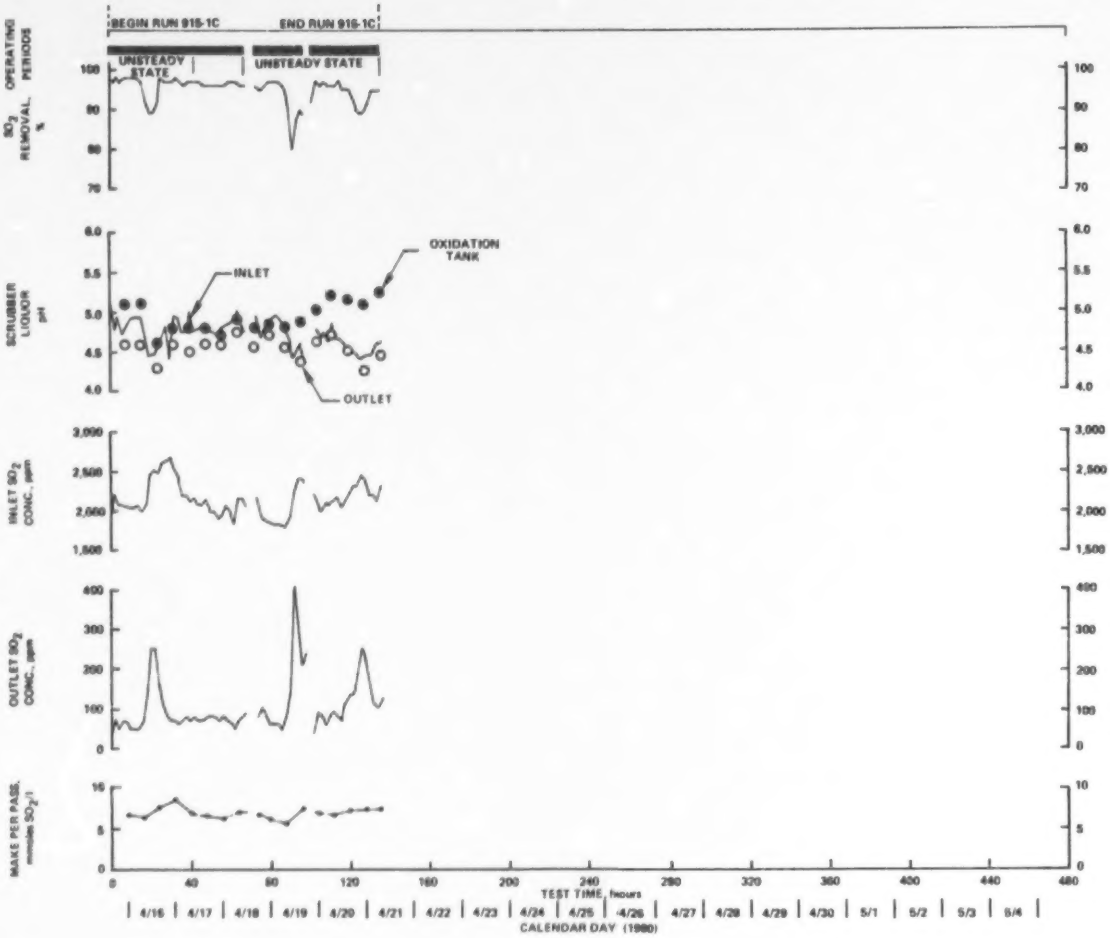
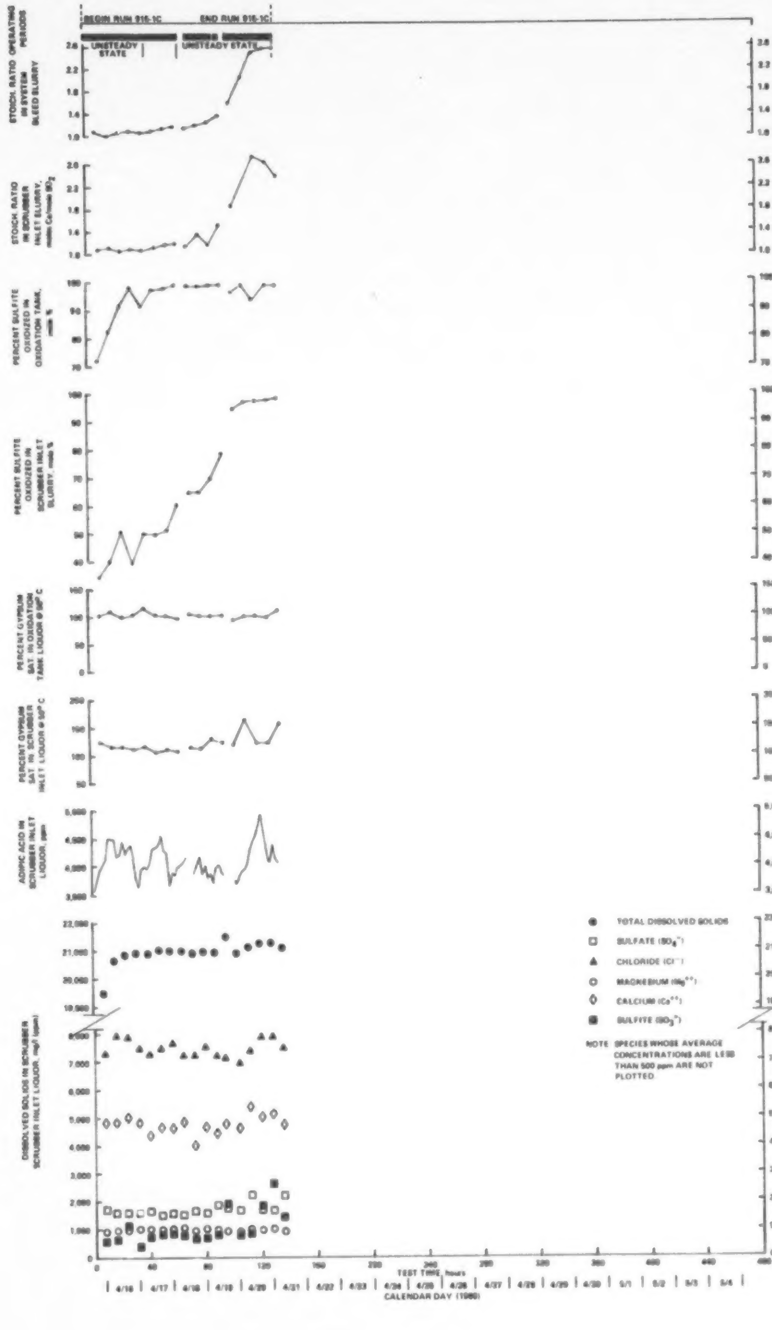


Figure F-22. Operating Data For Venturi/Spray Tower Run 915-1C



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 9.1 min.
Oxidation Tank Level = 17 ft.
Percent Solids Recirculated = 14.9-15.3 % wt
Discharge (Clarifier and Centrifuge) = 78-80 % wt
Air Rate to Oxidizer = 200 scfm
Total Pressure Drop, Excluding Mist Elim. = 15.6-16.5 in. H_2O
Venturi Pressure Drop = 8.7-9.5 in. H_2O
Mist Elim. Pressure Drop = 0.32-0.36 in. H_2O
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-22 (continued). Operating Data For Venturi/Spray Tower Run 915-1C

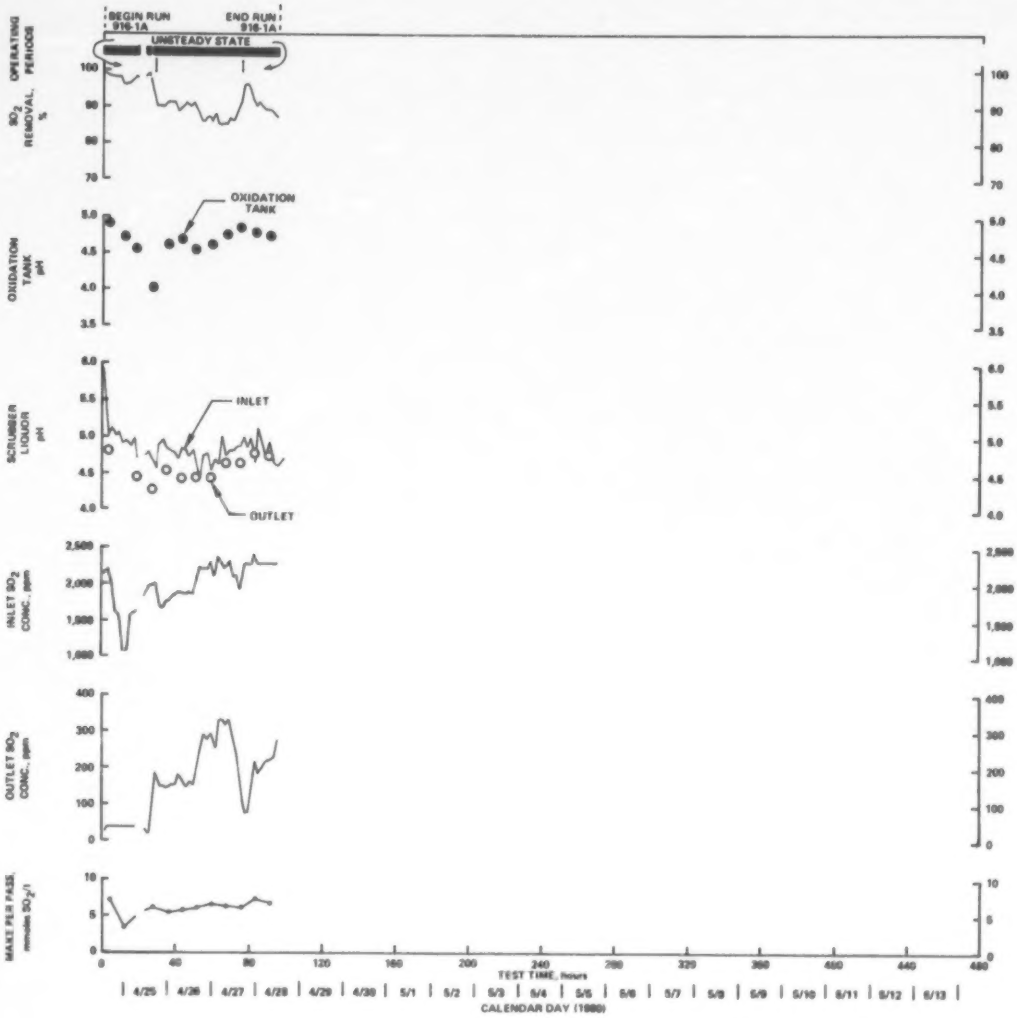
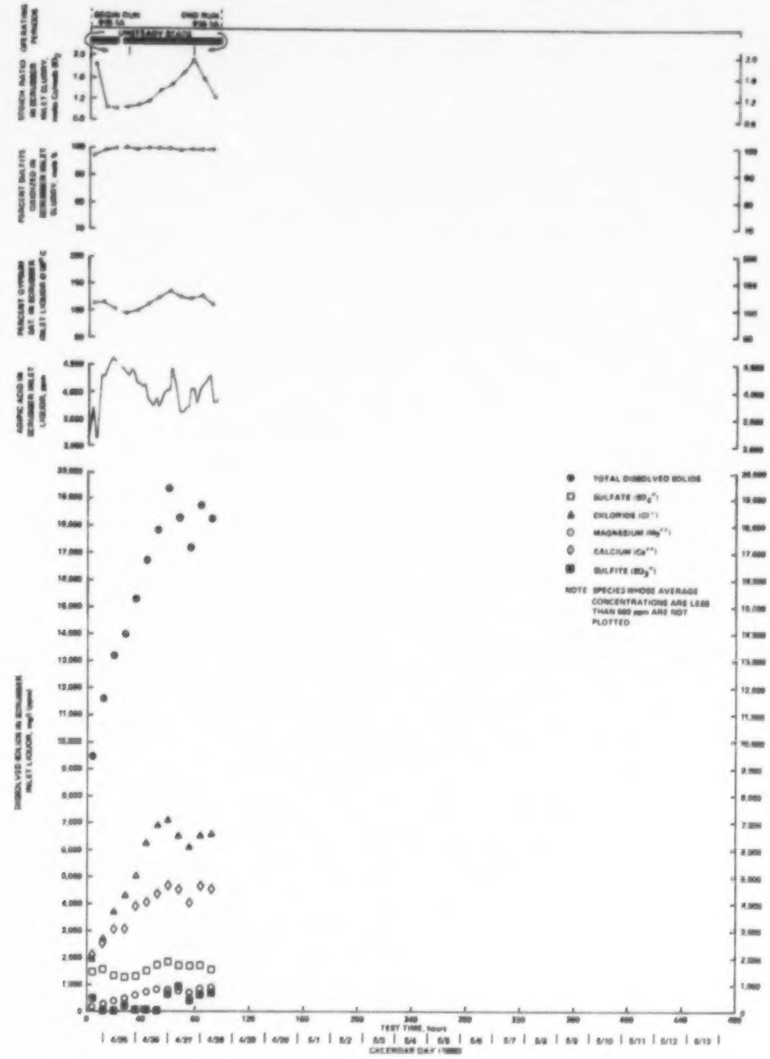


Figure F-23. Operating Data For Venturi/Spray Tower Run 916-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 21 gpm
Venturi L/G = 500 gal/Mcf
Spray Tower L/G = 18 gal/Mcf
No. of Spray Headers = 2
Residence Time of EHT = 18.2 min.
Residence Time of Oxidation Tank = 6.1 min.
Percent Solids Recirculated = 15.2-16.2 % wt
Discharge (Clarifier and Centrifuge) = 78-79 % wt
Total Pressure Drop, Excluding Mist Elim. = 14.9-16.3 in. H_2O
Venturi Pressure Drop = 8.7-9.9 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.35 in. H_2O
Air Stoichiometry = 1.5 atoms O/mole SO_2 absorbed
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-23 (continued). Operating Data For Venturi/Spray Tower Run 916-1A

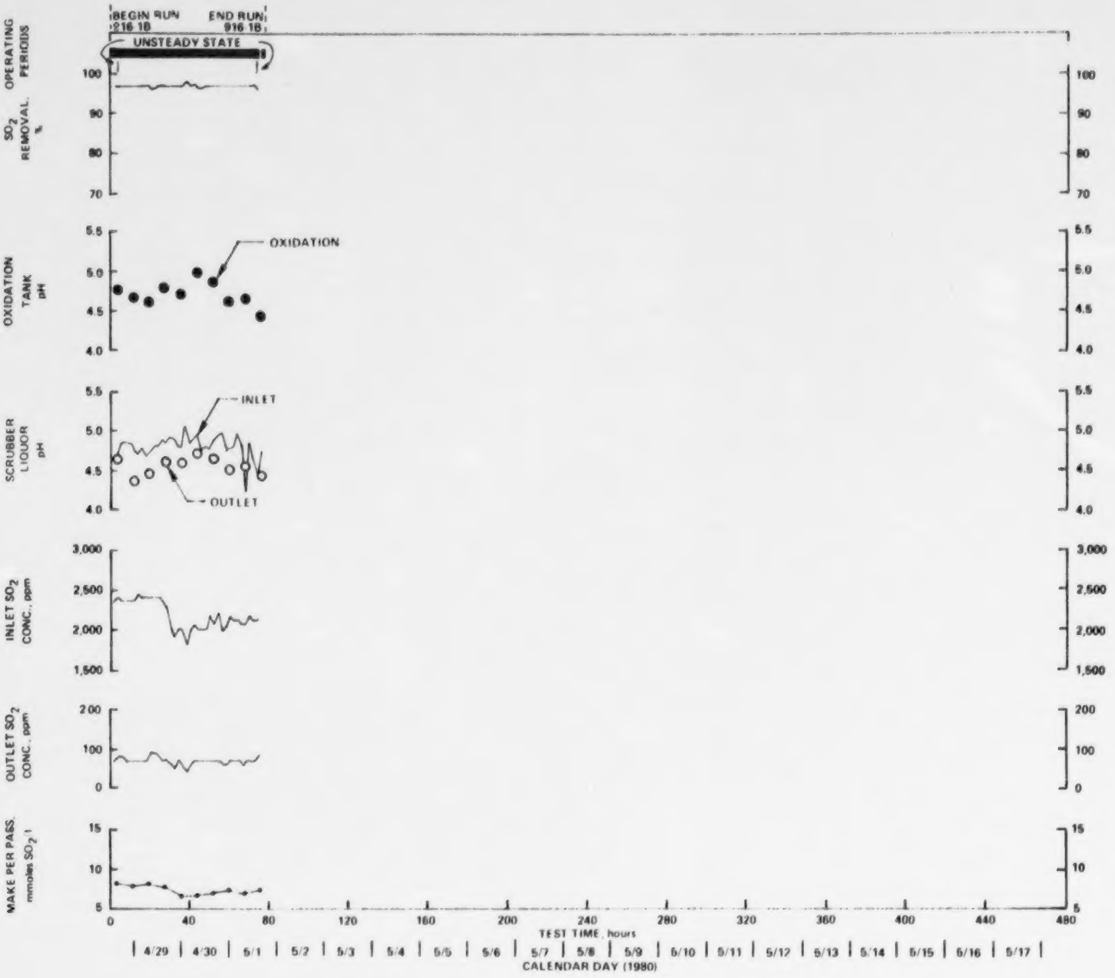
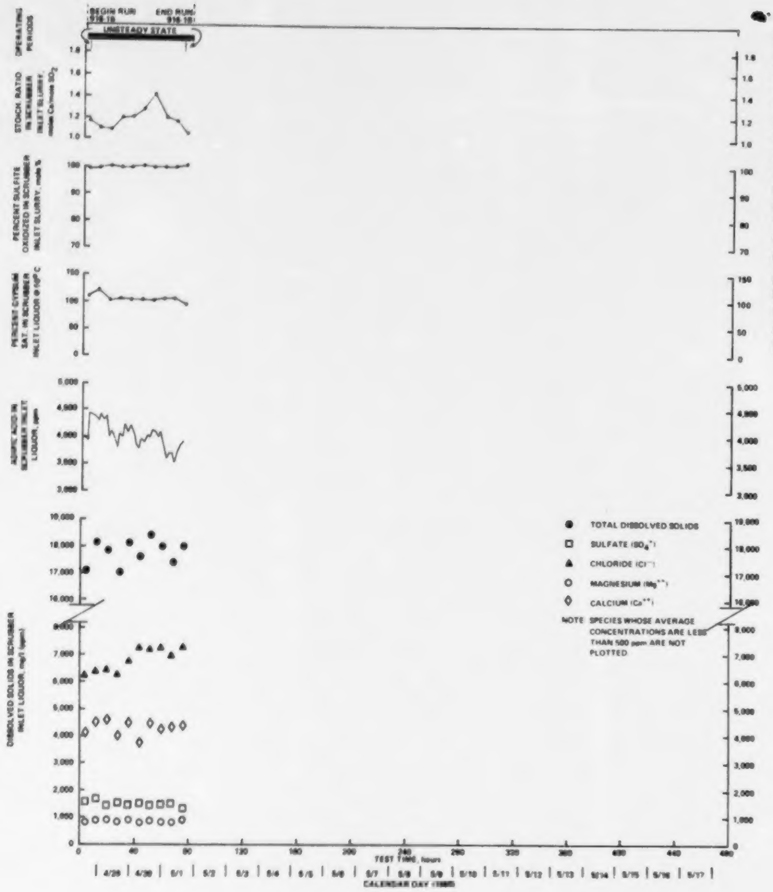


Figure F-24. Operating Data For Venturi/Spray Tower Run 916-1B



Gas Rate = 30,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1200 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 14.3-16.4 % wt
Discharge (Clarifier and Centrifuge) = 74-78 % wt
Total Pressure Drop, Excluding Mist Elim. = 10.2-10.8 in. H_2O
Venturi Pressure Drop = 5.2-6.2 in. H_2O
Mist Elim. Pressure Drop = 0.20-0.27 in. H_2O
Air Stoichiometry = 1.5 atoms O/mole SO_2 absorbed
Oxidation Tank Agitator Sped Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-24 (continued). Operating Data For Venturi/Spray Tower Run 916-1B

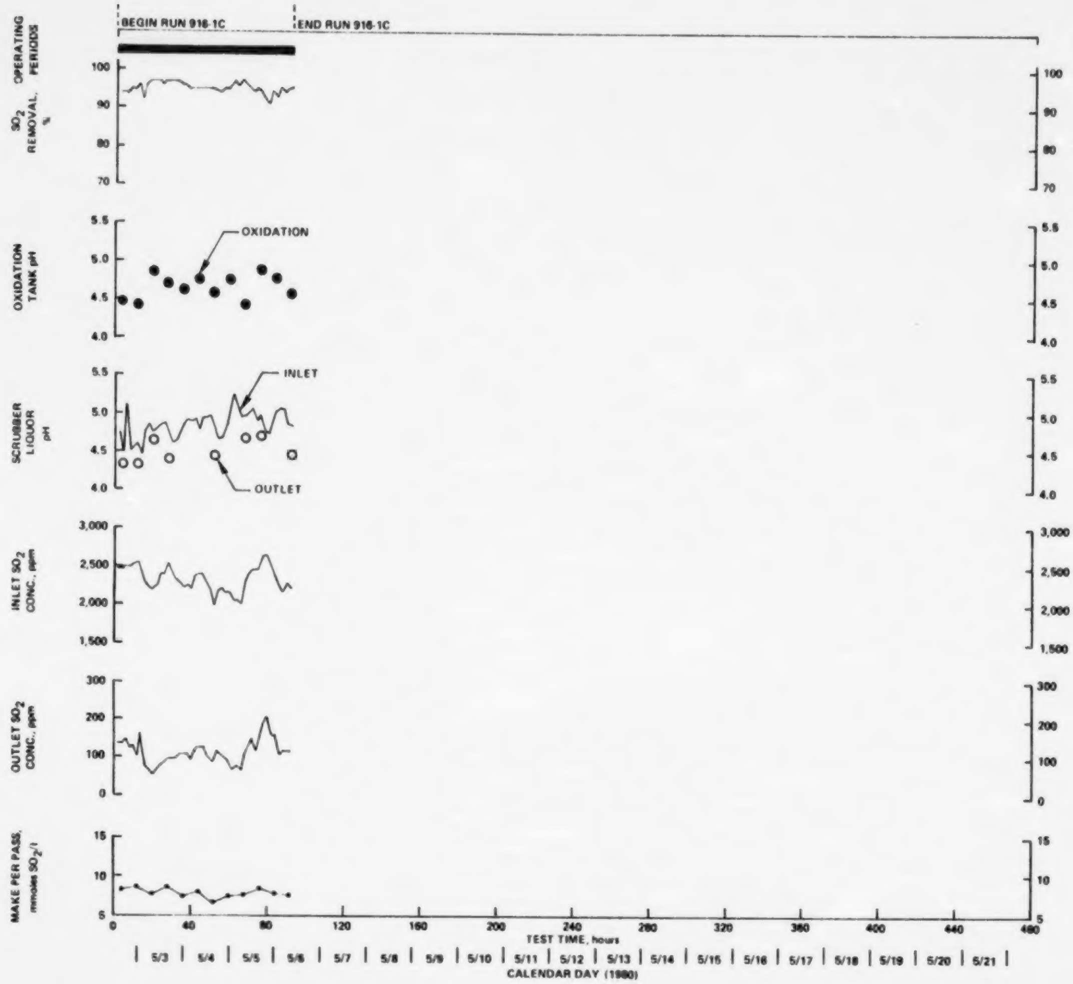
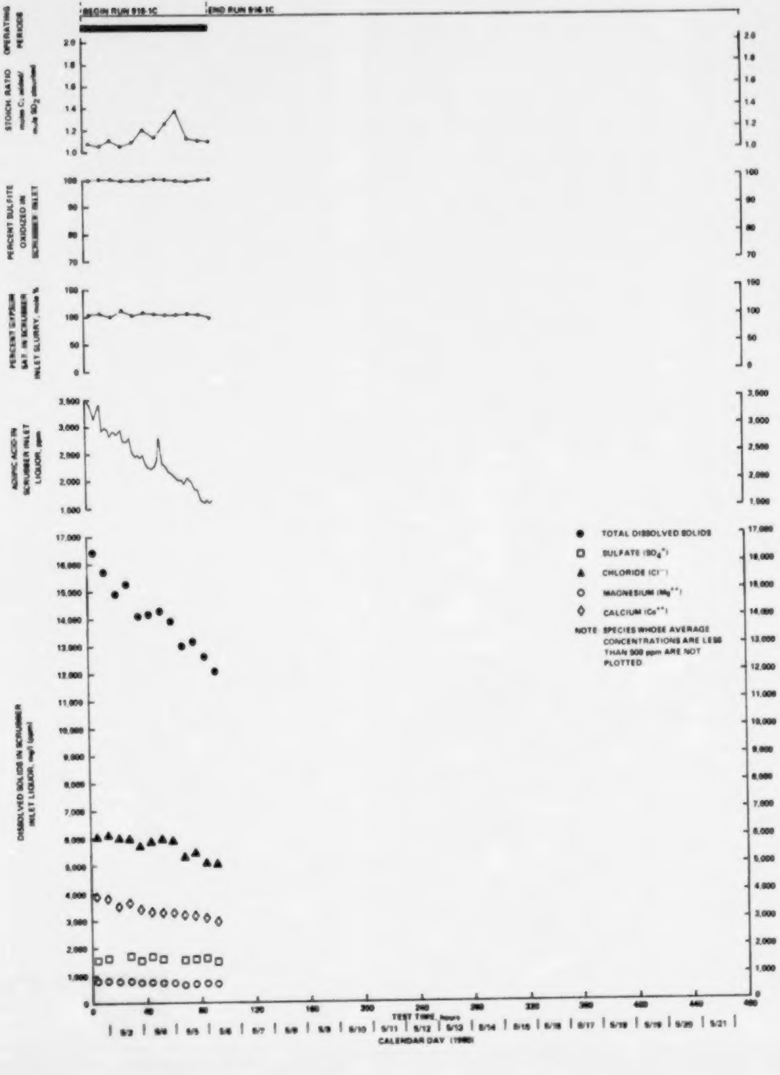


Figure F-25. Operating Data For Venturi/Spray Tower Run 916-1C



Gas Rate = 30,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1200 gpm
Venturi L/G = 25 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 13.5-16.7 % wt
Discharge (Clarifier only) = 26-42 % wt
Total Pressure Drop, Excluding Mist Elim. = 11.4-13.2 in. H_2O
Venturi Pressure Drop = 6.4-7.0 in. H_2O
Mist Elim. Pressure Drop = 0.27-0.31 in. H_2O
Air Flow to Oxidizer = 160-156 scfm
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-25 (continued). Operating Data For Venturi/Spray Tower Run 916-1C

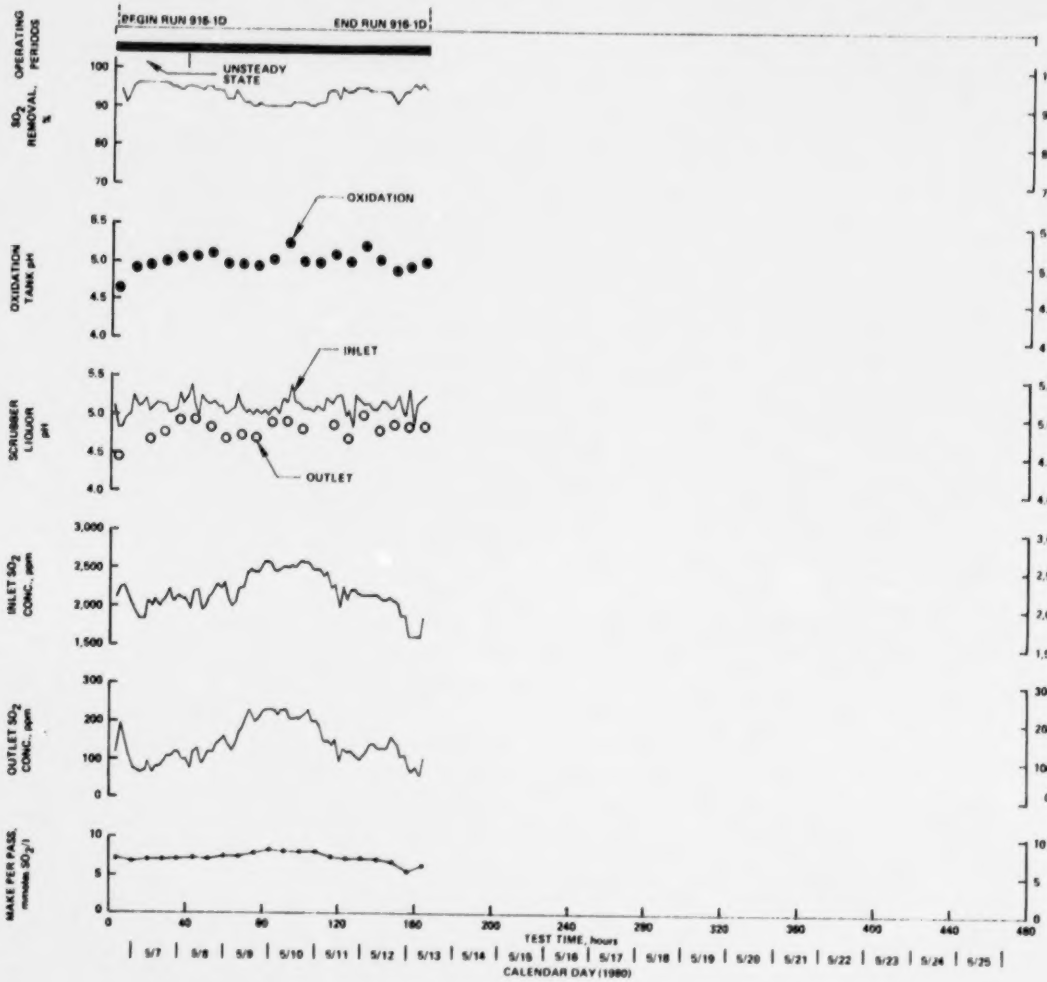
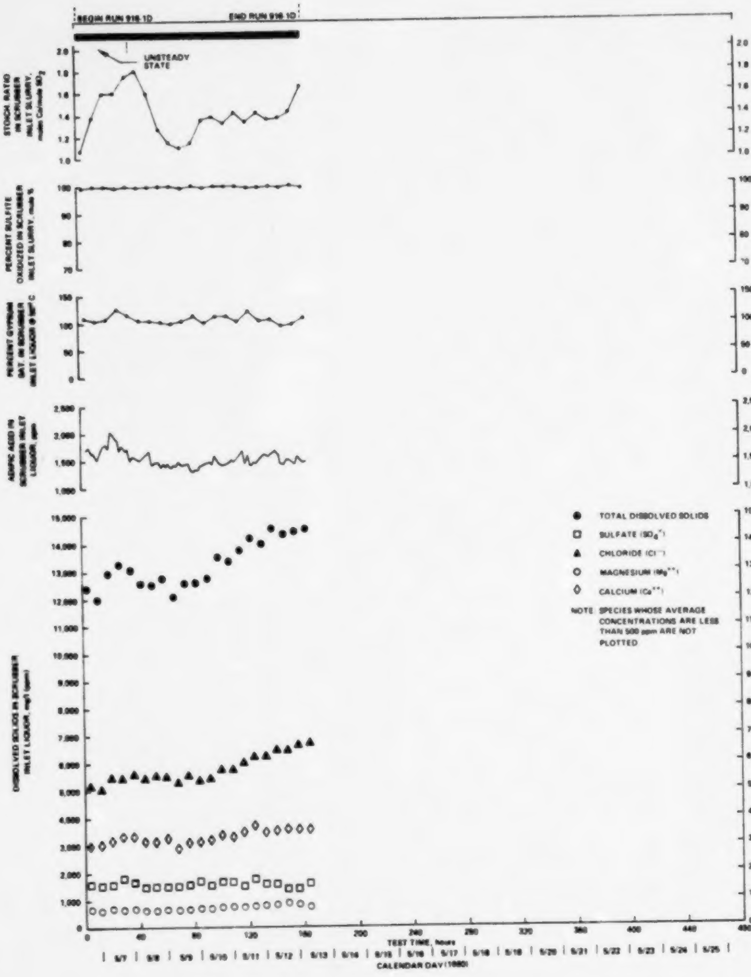


Figure F-26. Operating Data For Venturi/Spray Tower Run 916-1D



Gas Rate = 30,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor RAte to Spray Tower = 1200 gpm
Venturi L/G = 25 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 14.4-15.6 % wt
Discharge (Clarifier and Centrifuge /Filter) = 80-88 % wt
Total Pressure Drop, Excluding Mist Elim. = 10.9-11.6 in. H_2O
Venturi Pressure Drop = 5.1-6.8 in. H_2O
Mist Elim. Pressure Drop = 0.23-0.38 in. H_2O
Air Flow to Oxidizer = 151 scfm
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-26 (continued). Operating Data For Venturi/Spray Tower Run 916-1D

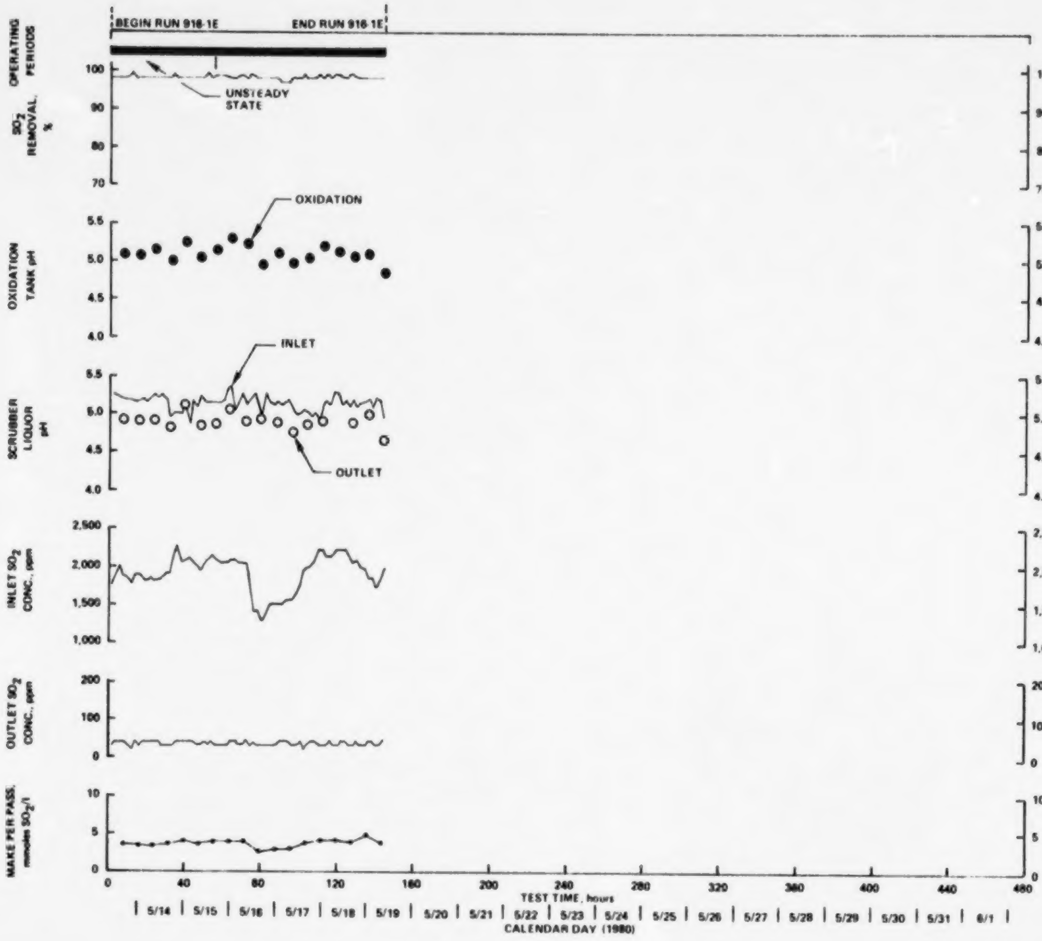
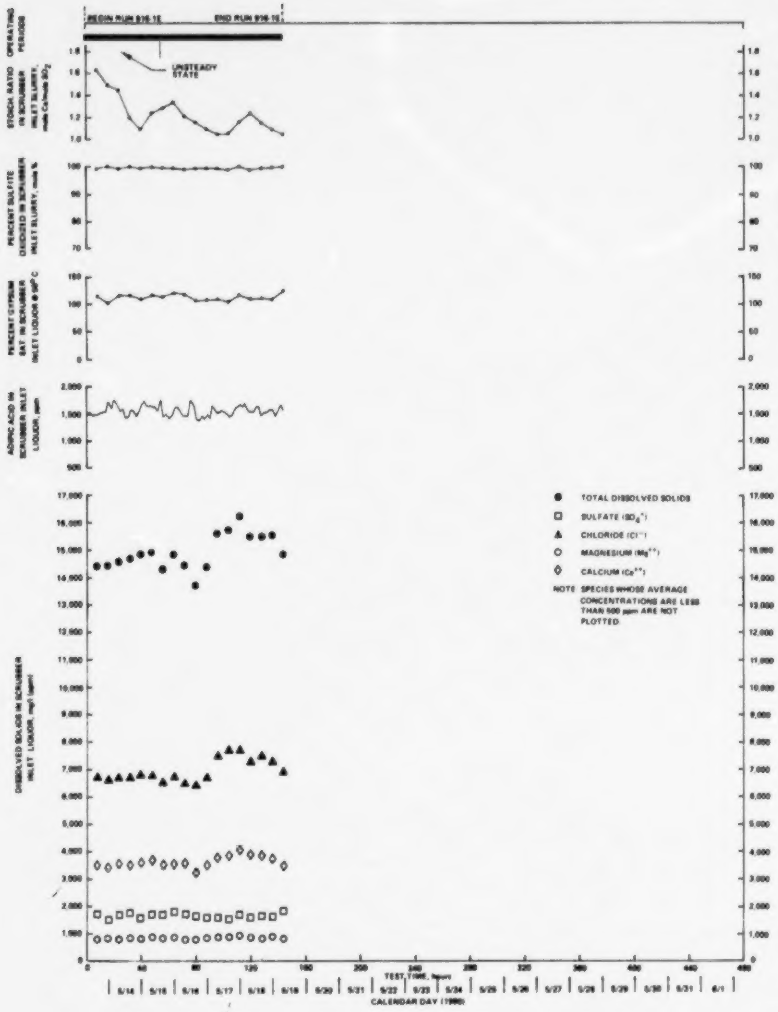


Figure F-27. Operating Data For Venturi/Spray Tower Run 916-1E



Gas Rate = 20,000 acfm @ 300° F
Spray Tower Gas Velocity = 5.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 38 gal/Mcf
Spray Tower L/G = 100 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 13.5-16.8 % wt
Discharge (Clarifier and Filter) = 87-90 % wt
Total Pressure Drop, Excluding Mist Elim. = 9.8-10.2 in. H_2O
Venturi Pressure Drop = 7.3-7.8 in. H_2O
Mist Elim. Pressure Drop = 0.15-0.18 in. H_2O
Air Flow to Oxidizer = 90 scfm
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-27 (continued). Operating Data For Venturi/Spray Tower Run 916-1E

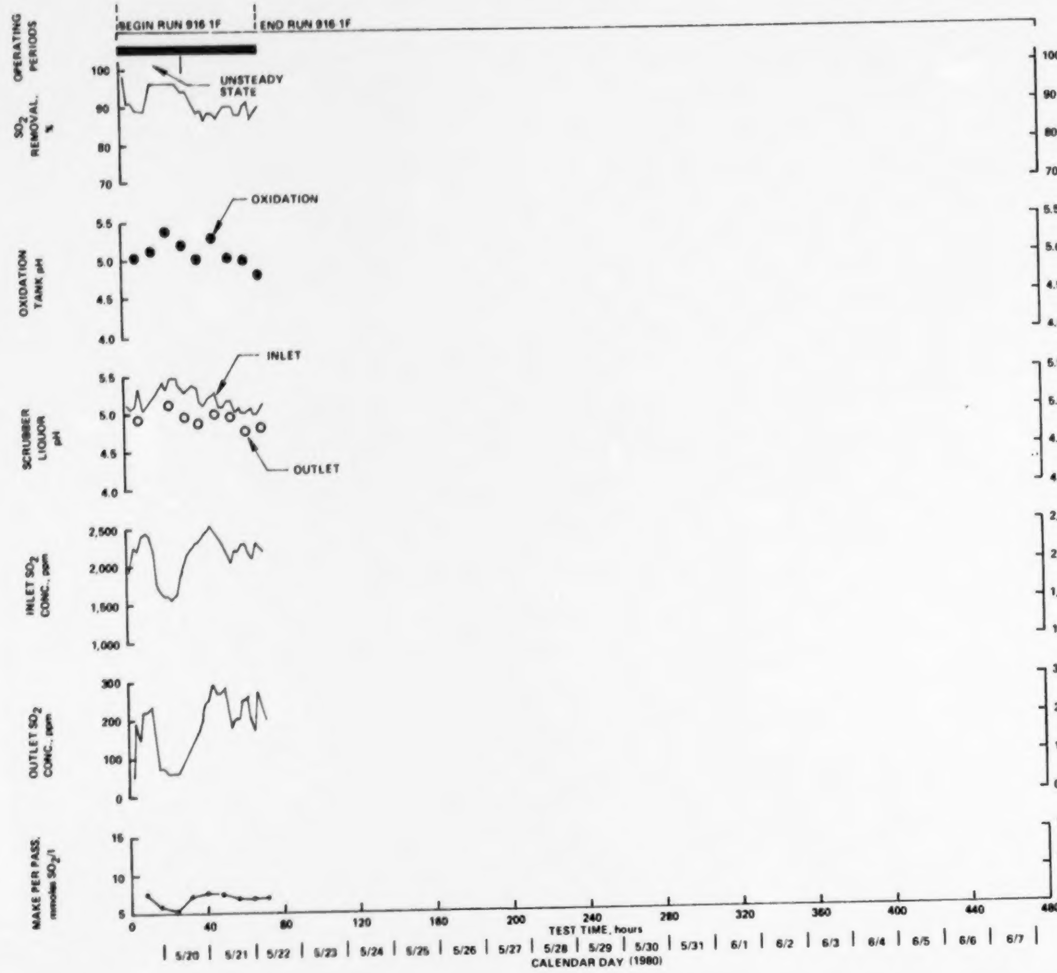
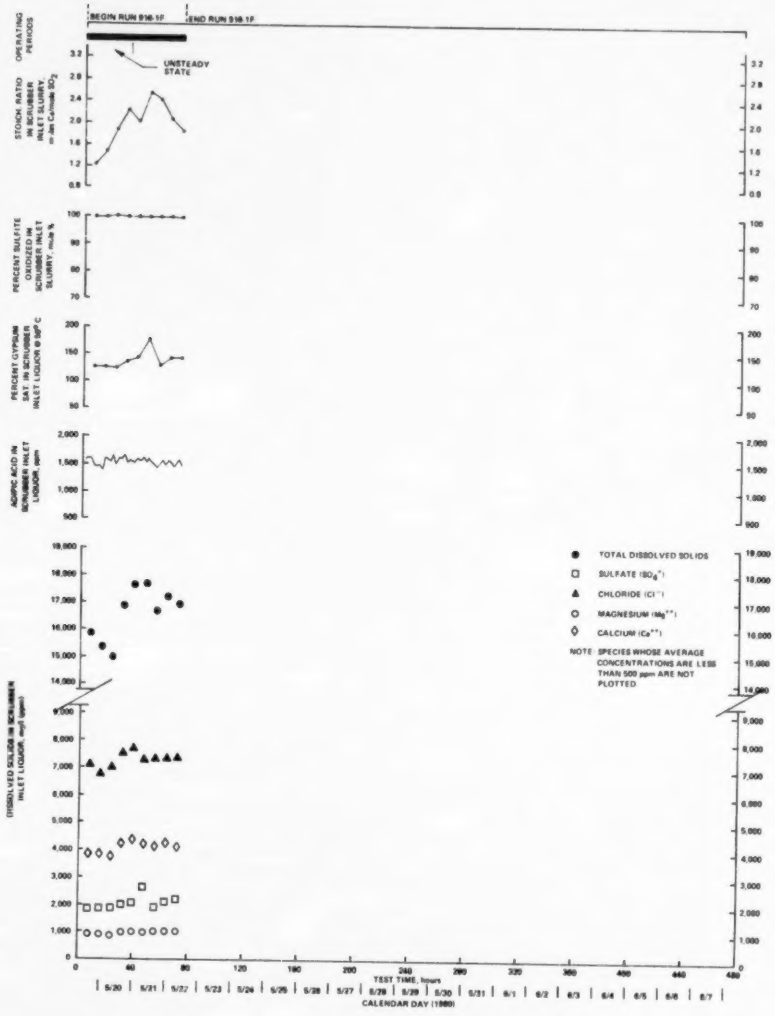


Figure F-28. Operating Data For Venturi/Spray Tower Run 916-1F



Gas Rate = 30,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1200 gpm
Venturi L/G = 25 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 15.3-16.4 % wt
Discharge (Clarifier and Filter) = 83-85 % wt
Total Pressure Drop, Excluding Mist Elim. = 10.7-11.1 in. H_2O
Venturi Pressure Drop = 6.1-6.5 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.32 in. H_2O
Air Flow to Oxidizer = 149 scfm
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-28 (continued). Operating Data For Venturi/Spray Tower Run 916-1F

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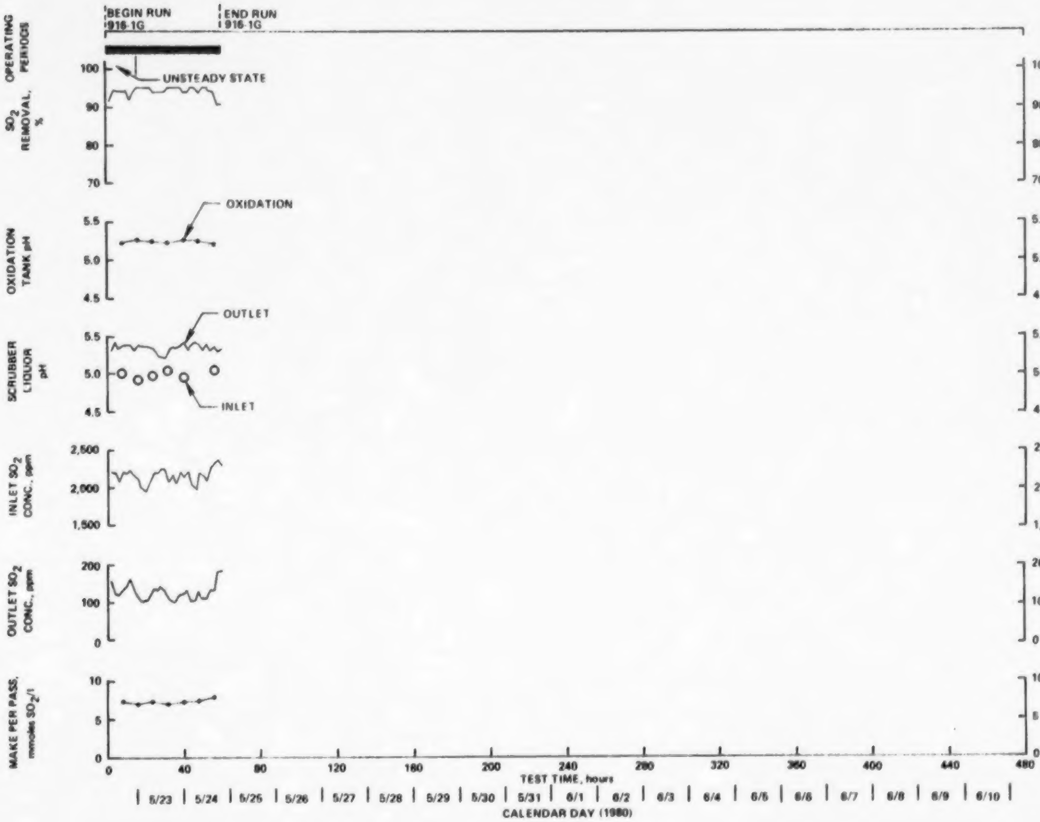
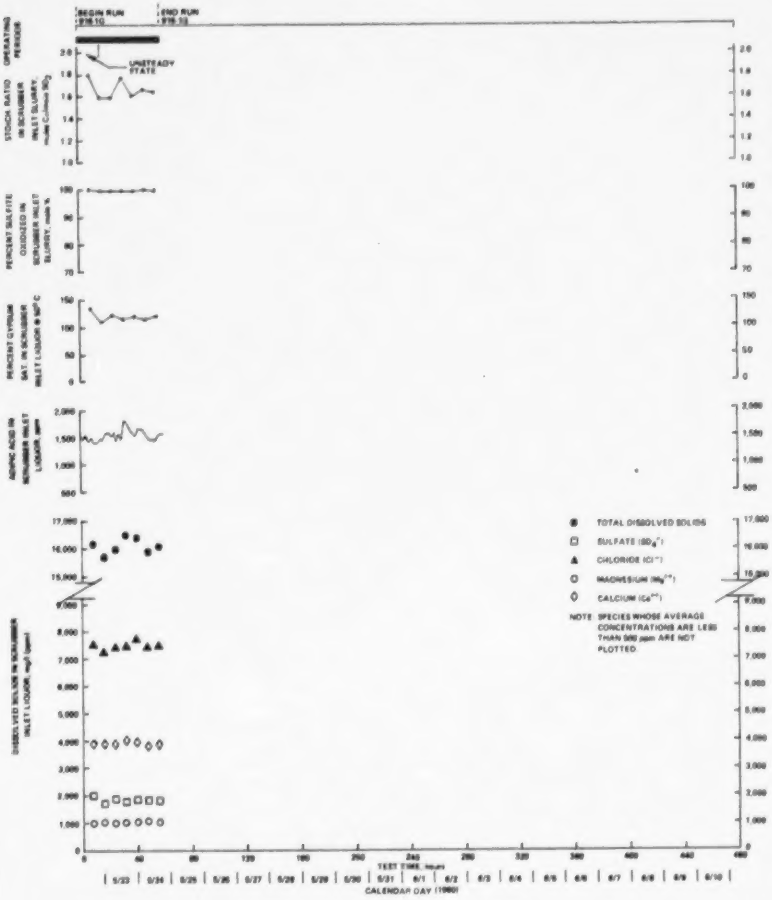


Figure F-29. Operating Data For Venturi/Spray Tower Run 916-1G



Gas Rate = 30,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower 1200 gpm
Venturi L/G = 25 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 14.1-17.0 % wt
Discharge (Clarifier and Filter) = 82-88 % wt
Total Pressure Drop, Excluding Mist Elim. = 10.6-11.0 in. H_2O
Venturi Pressure Drop = 6.0-6.2 in. H_2O
Mist Elim. Pressure Drop = 0.29-0.31 in. H_2O
Air Flow to Oxidizer = 246 acfm
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liqior Returned toEHT

Figure F-29 (continued). Operating Data For Venturi/Spray Tower Run 916-1G

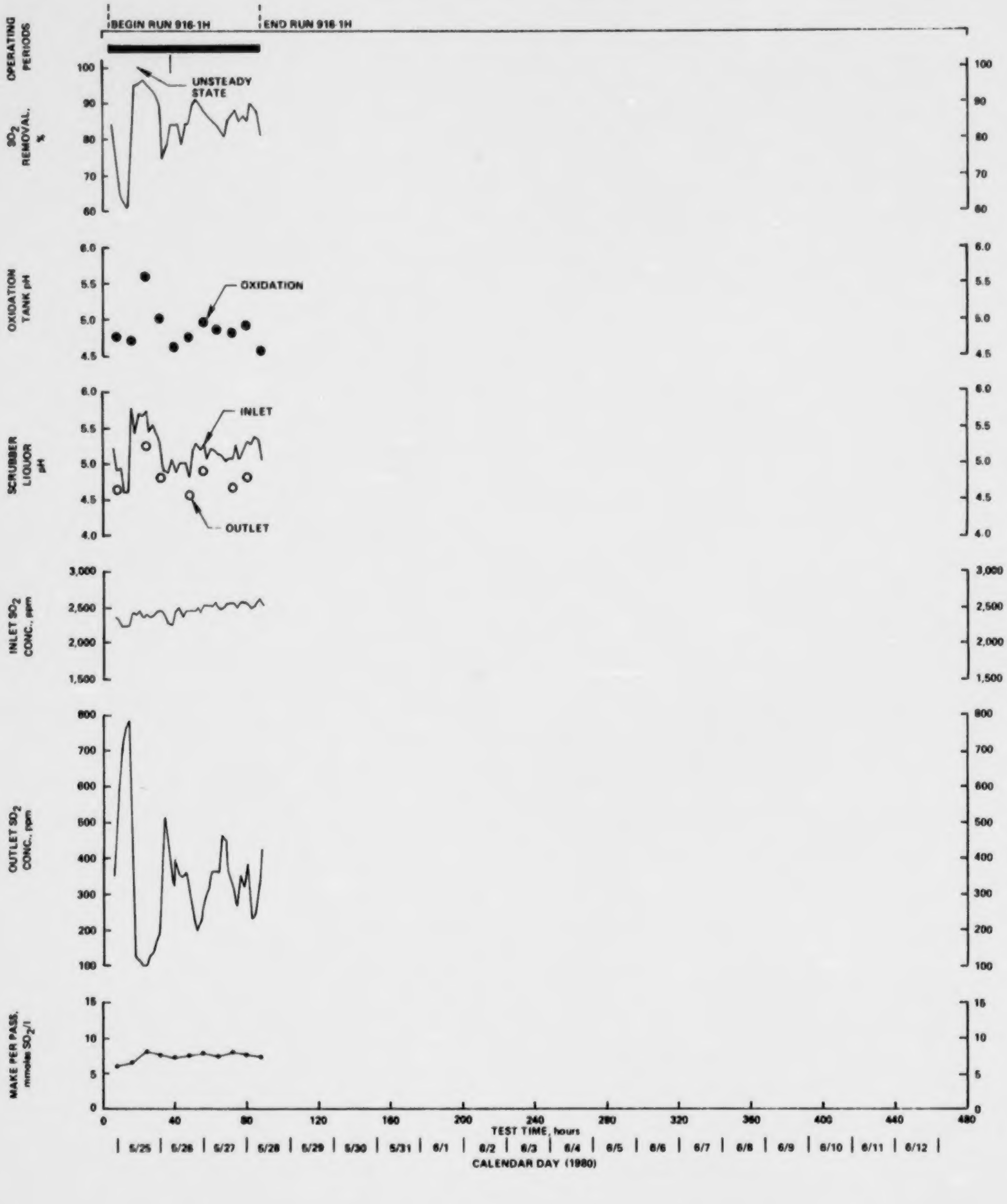
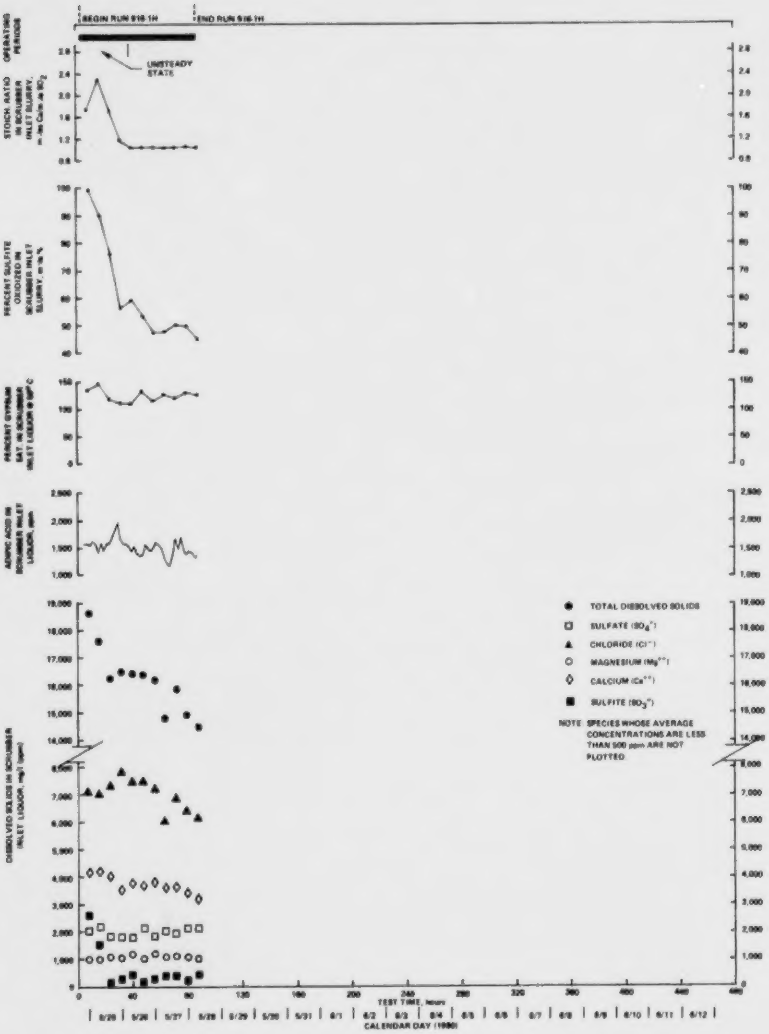


Figure F-30. Operating Data For Venturi/Spray Tower Run 916-1H



Gas Rate = 30,000 acfm @ 300° F
Spray Tower Gas Velocity = 8.1 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1200 gpm
Venturi L/G = 25 gal/Mcf
Spray Tower L/G = 50 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 11.1 min.
Residence Time of Oxidation Tank = 3.8 min.
Percent Solids Recirculated = 14.7-16.5 % wt
Discharge (Clarifier and Filter) = 58-60 % wt
Total Pressure Drop, Excluding Mist Elim. = 9.7-10.2 in. H_2O
Venturi Pressure Drop = 5.9-6.3 in. H_2O
Mist Elim. Pressure Drop = 0.29-0.32 in. H_2O
Air Flow to Oxidizer = 0 scfm
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-30 (continued). Operating Data For Venturi/Spray Tower Run 916-1H

B

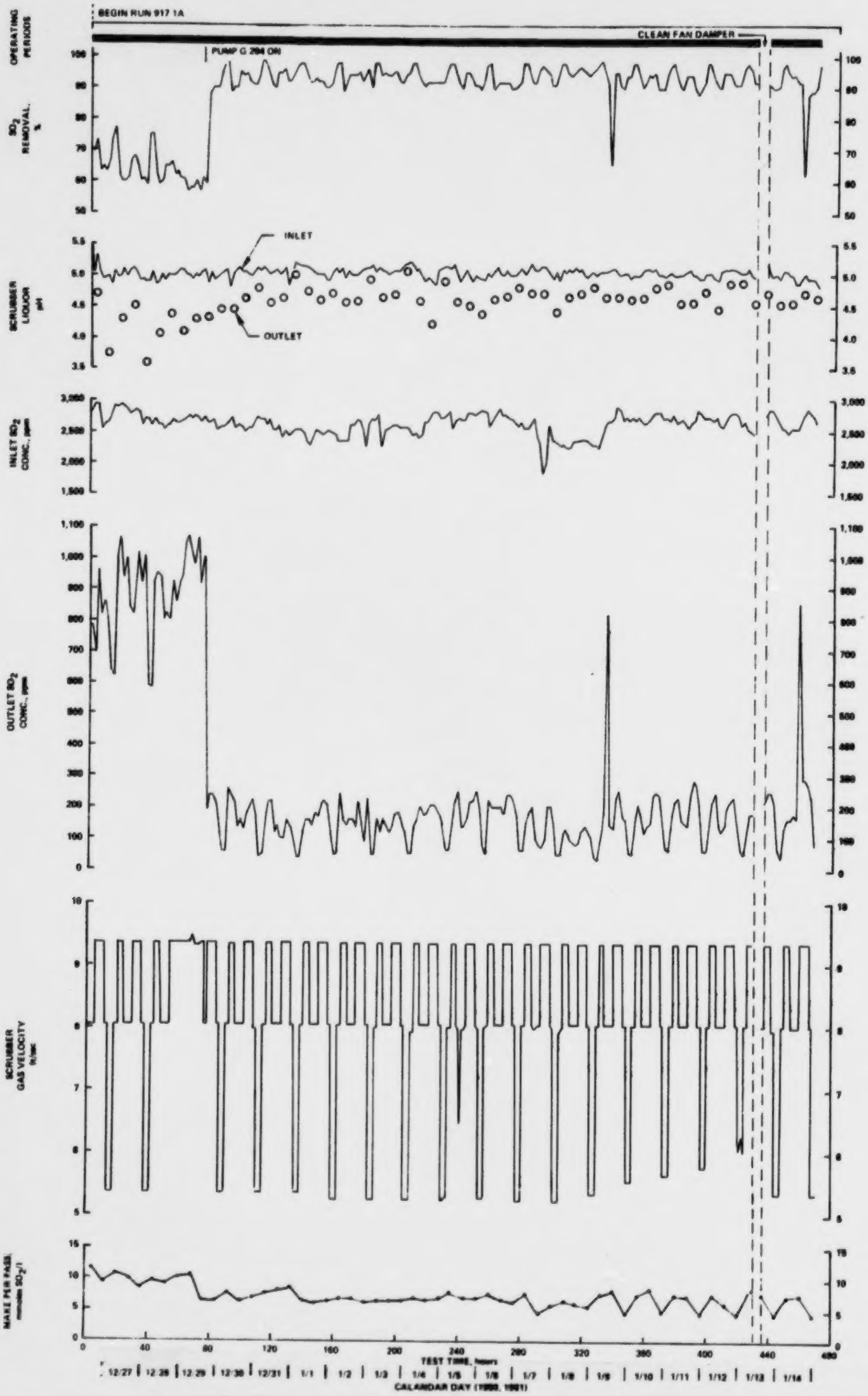


Figure F-31. Operating Data For Spray Tower Run 917-1A

F

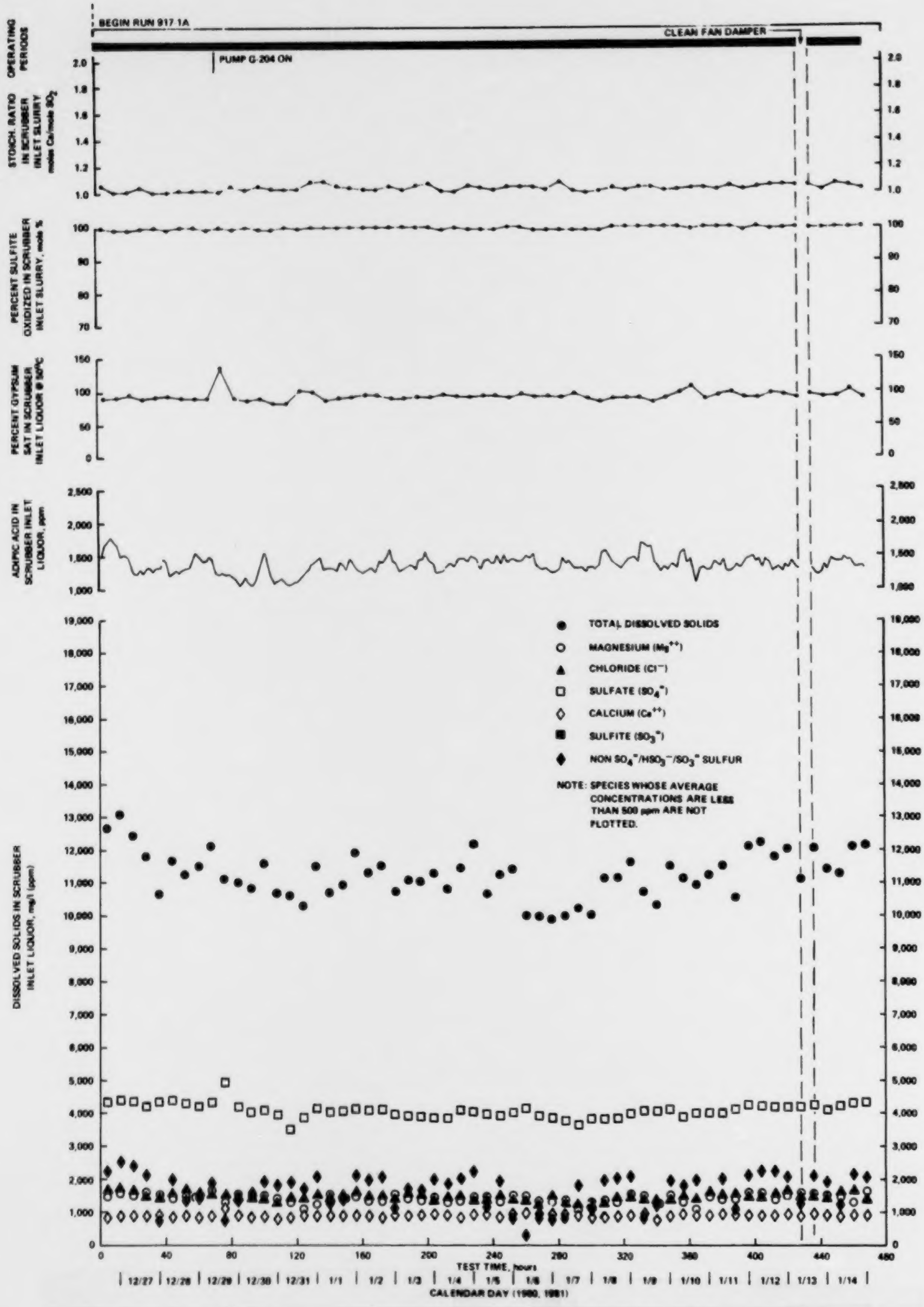


Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A

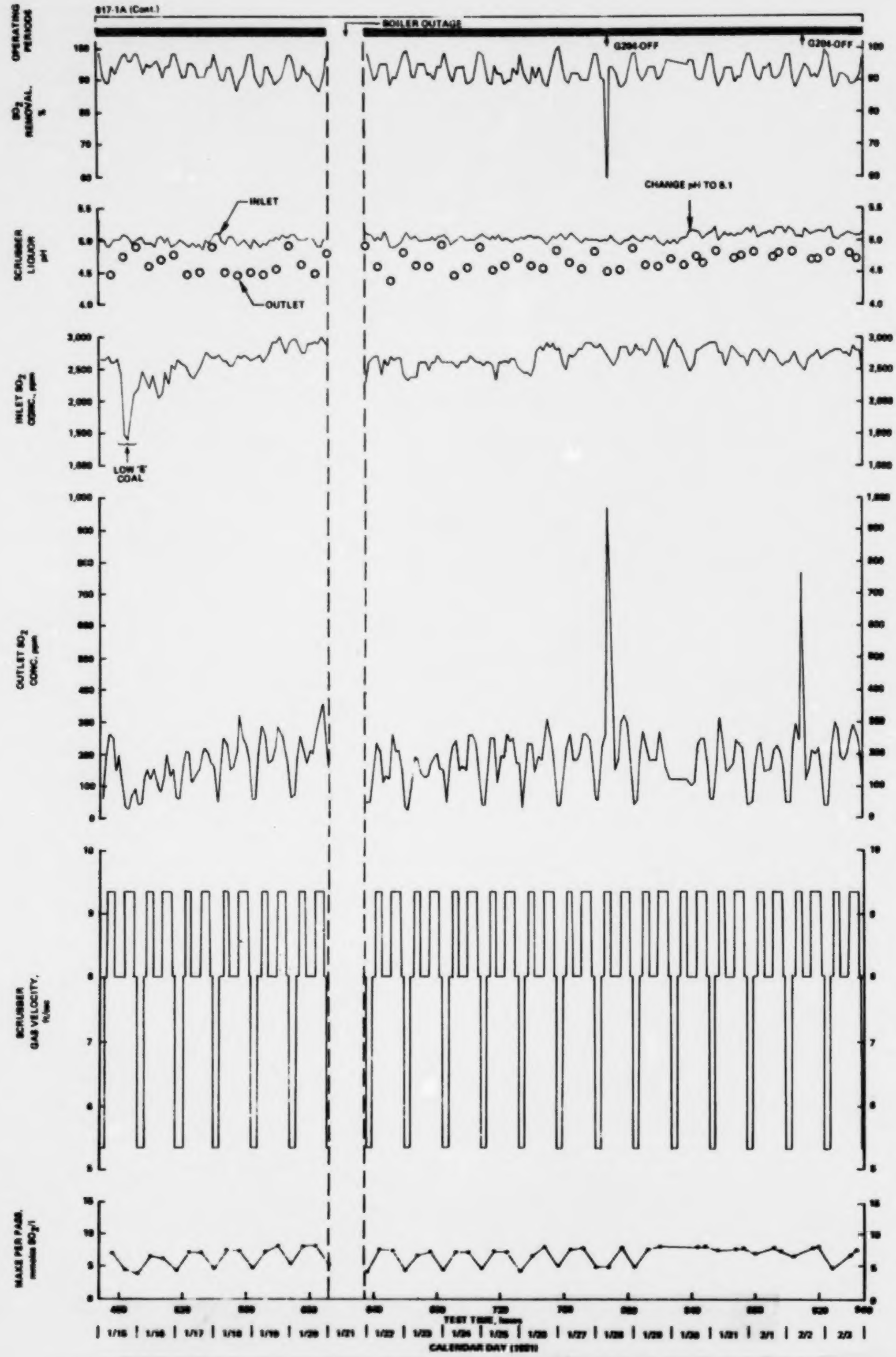


Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A

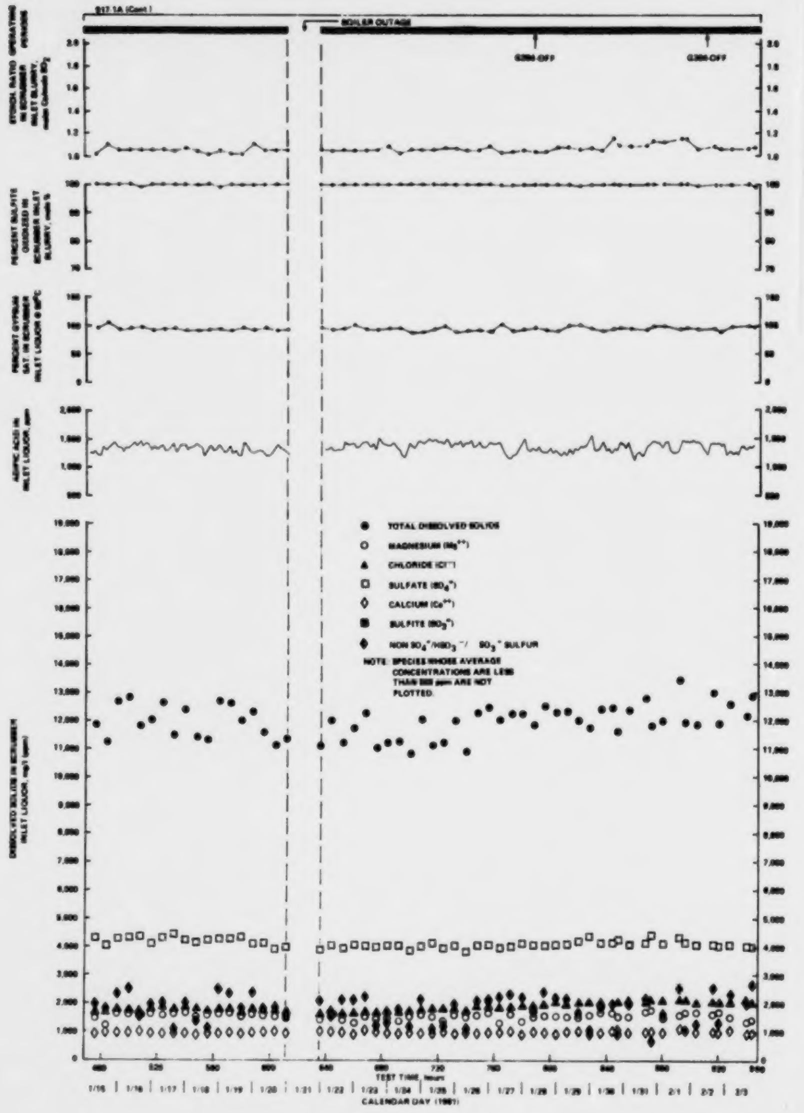


Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A

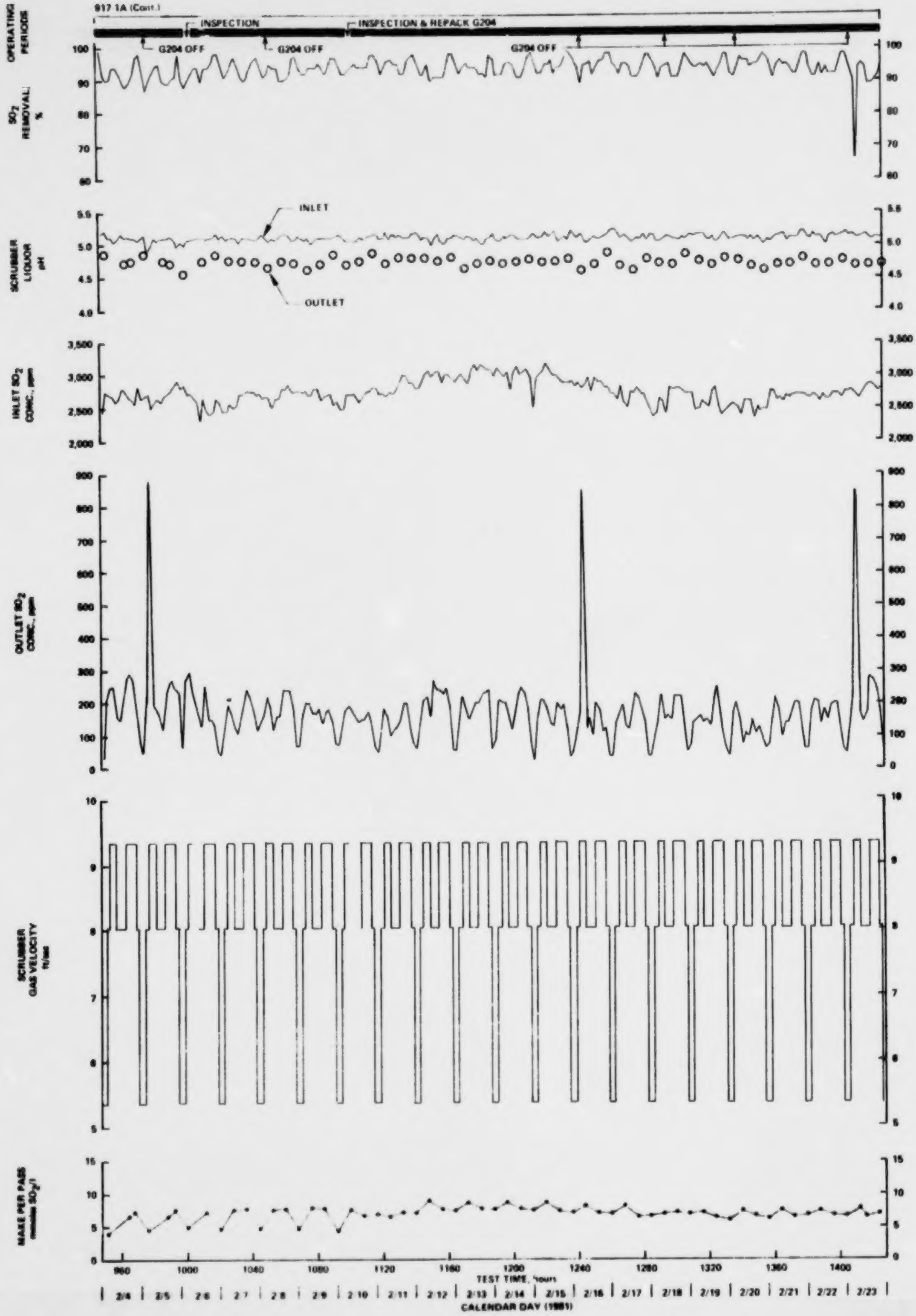


Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A

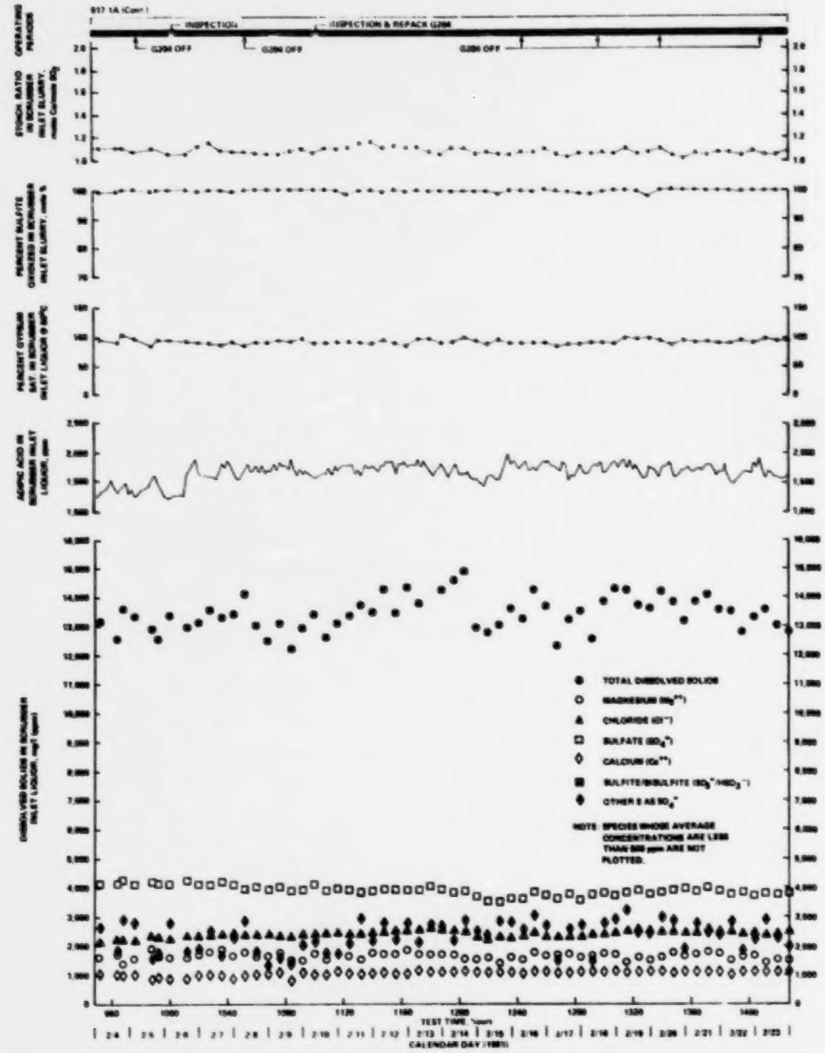


Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A

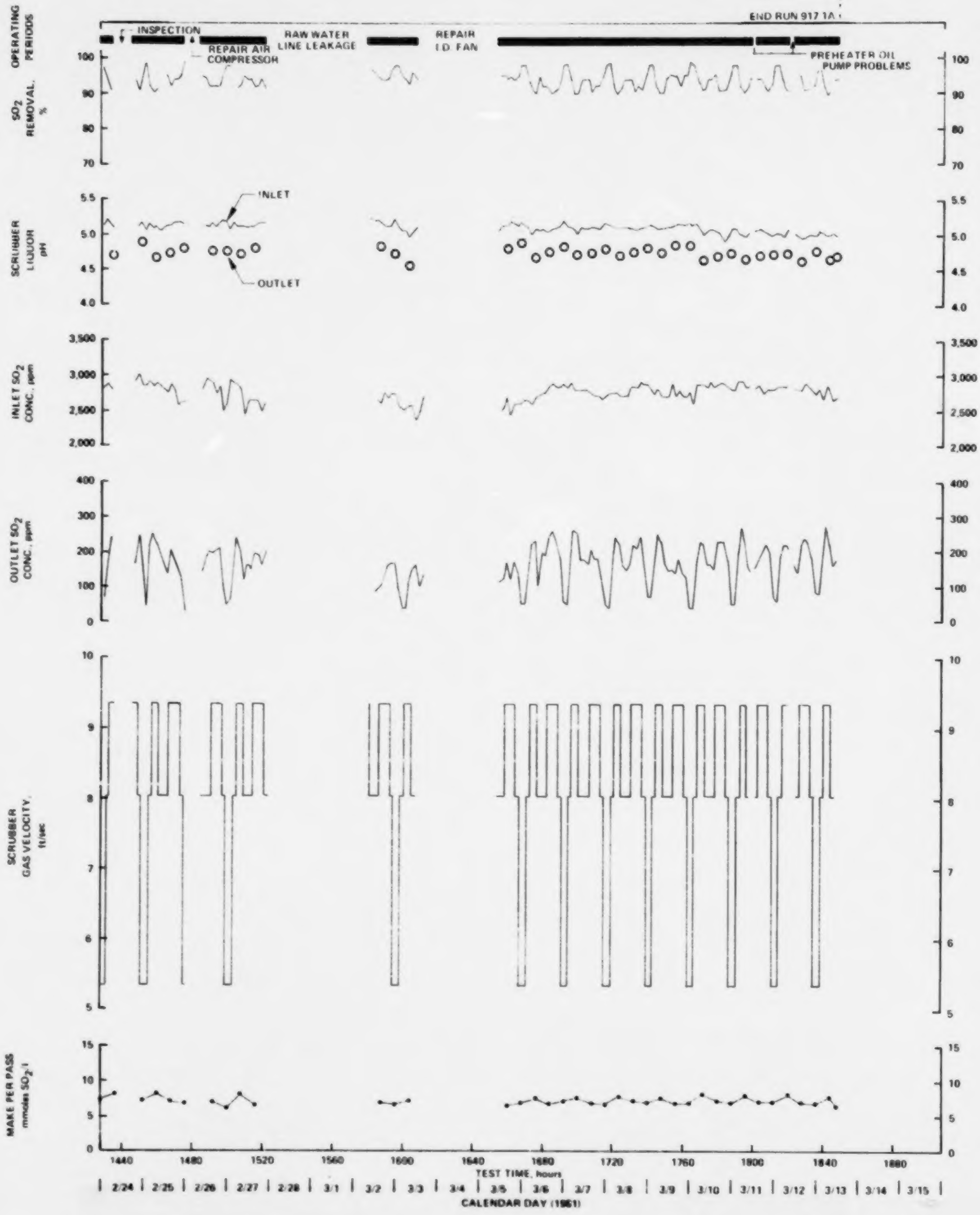
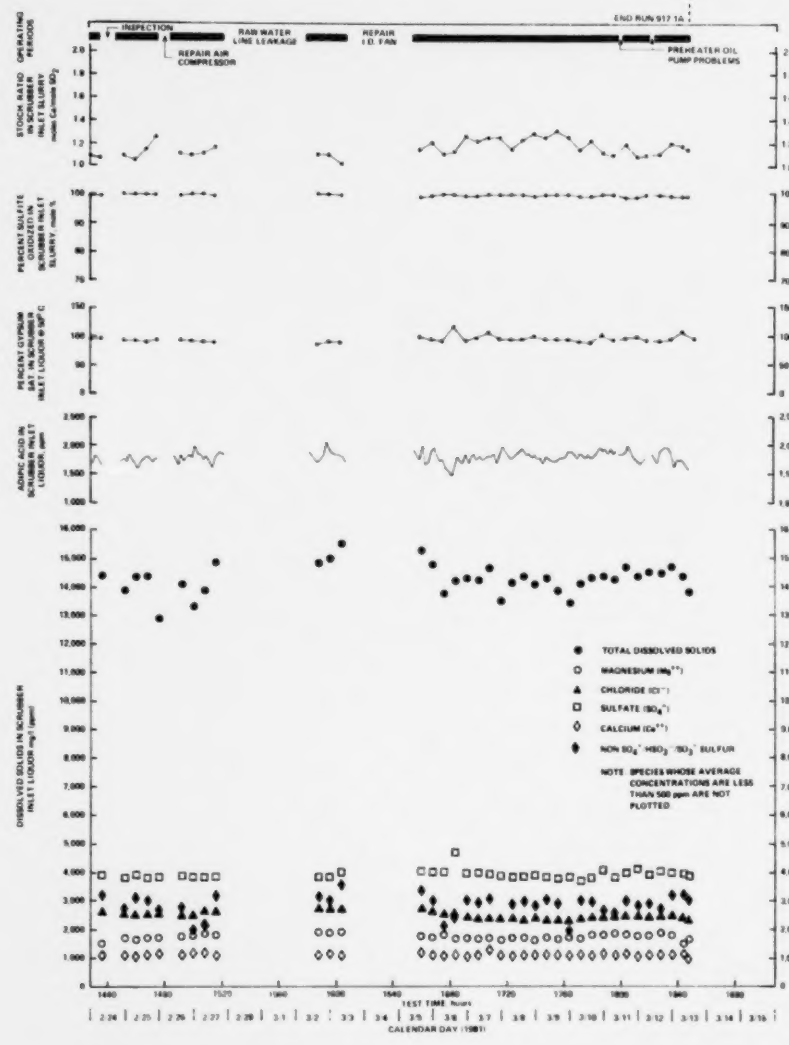


Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A



Gas Rate = 20,000 - 35,000 acfm @ 300°F
Scrubber Gas Velocity = 5.35 - 9.35 ft/sec @ 125°F
Lqiuor Rate = 2400 gpm
L/G = 85 - 150 gal/Mcf
EHT Residence Time = 8.3 min
EHT Level = 8.5 ft
Oxidation Tank Level = 18 ft
Oxidation Tank Residence Time = 2.8 min
Adipic Acid Dry Fed to EHT
Limestone addition to EHT
Solids Recirculated = 14.3 to 16.2 wt %
Total Pressure Drop, Excluding Mist Elim.
= 1.5 - 3.0 in. H_2O
Mist Elim. Pressure Drop = 0.05 - 0.28 in. H_2O
Discharge (Clarifier and Drum or Belt Filter) solids
Concentration = 82 - 88 wt %
Clarified Liquor Returned to EHT

Figure F-31 (continued). Operating Data For Spray Tower Run 917-1A

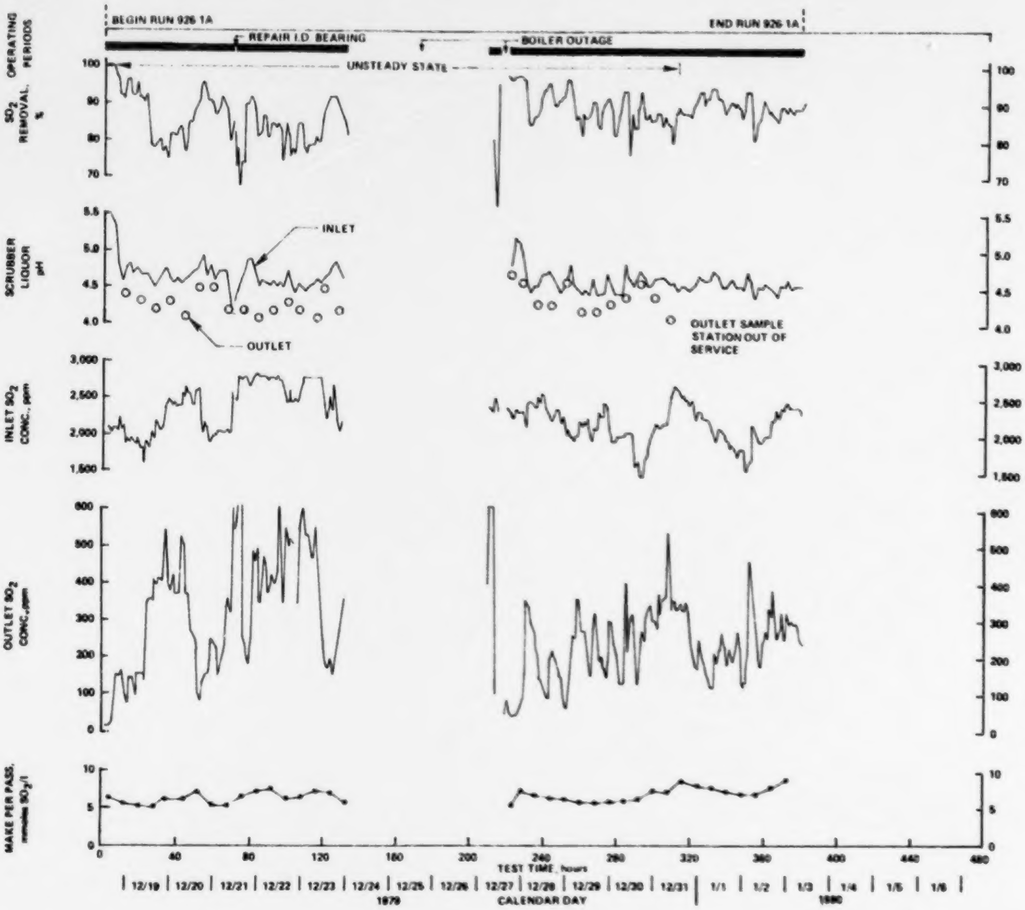
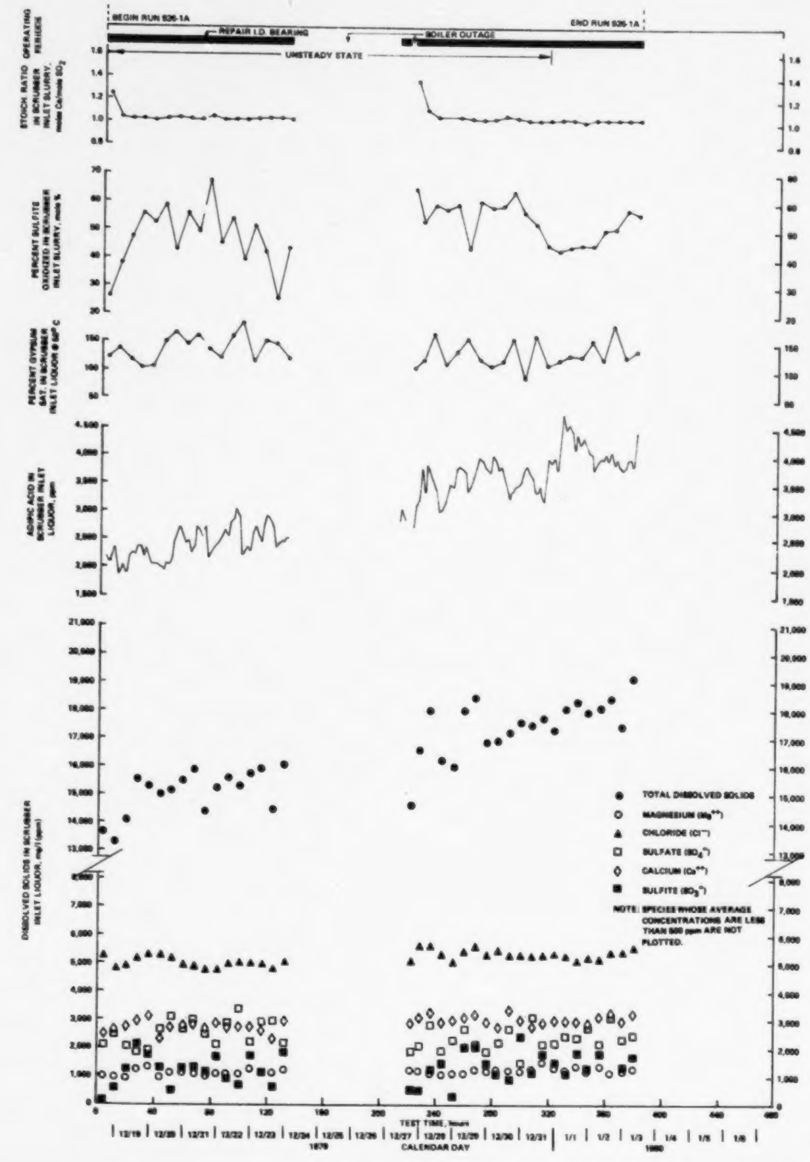


Figure F-32. Operating Data For Venturi/Spray Tower Run 926-1A



Gas Rate = 35,000 acfm @ 300° F

Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F

Liquor Rate to Venturi = 600 gpm

Liquor Rate to Spray Tower = 1600 gpm

Venturi L/G = 21 gal/Mcf

Spray Tower L/G = 57 gal/Mcf

No. of Spray Headers = 4

Residence Times:

Effluent Hold Tank = 9.1 min

Solids Recirculated, 14.9-16.1 wt %

Venturi Pressure Drop = 9 in. H_2O

Total Pressure Drop, Excl. Mist Elim.
= 14.7-15.3 in. H_2O

Mist Elim. Pressure Drop = 0.25-0.31 in. H_2O

Discharge (Clarifier & Centrifuge) Solids
Concentration = 67-71 wt %

Limestone Addition to EHT

Adipic Acid Dry Fed to EHT

Clarified Liquor Returned to EHT

Figure F-32 (continued). Operating Data For Venturi/Spray Tower Run 926-1A

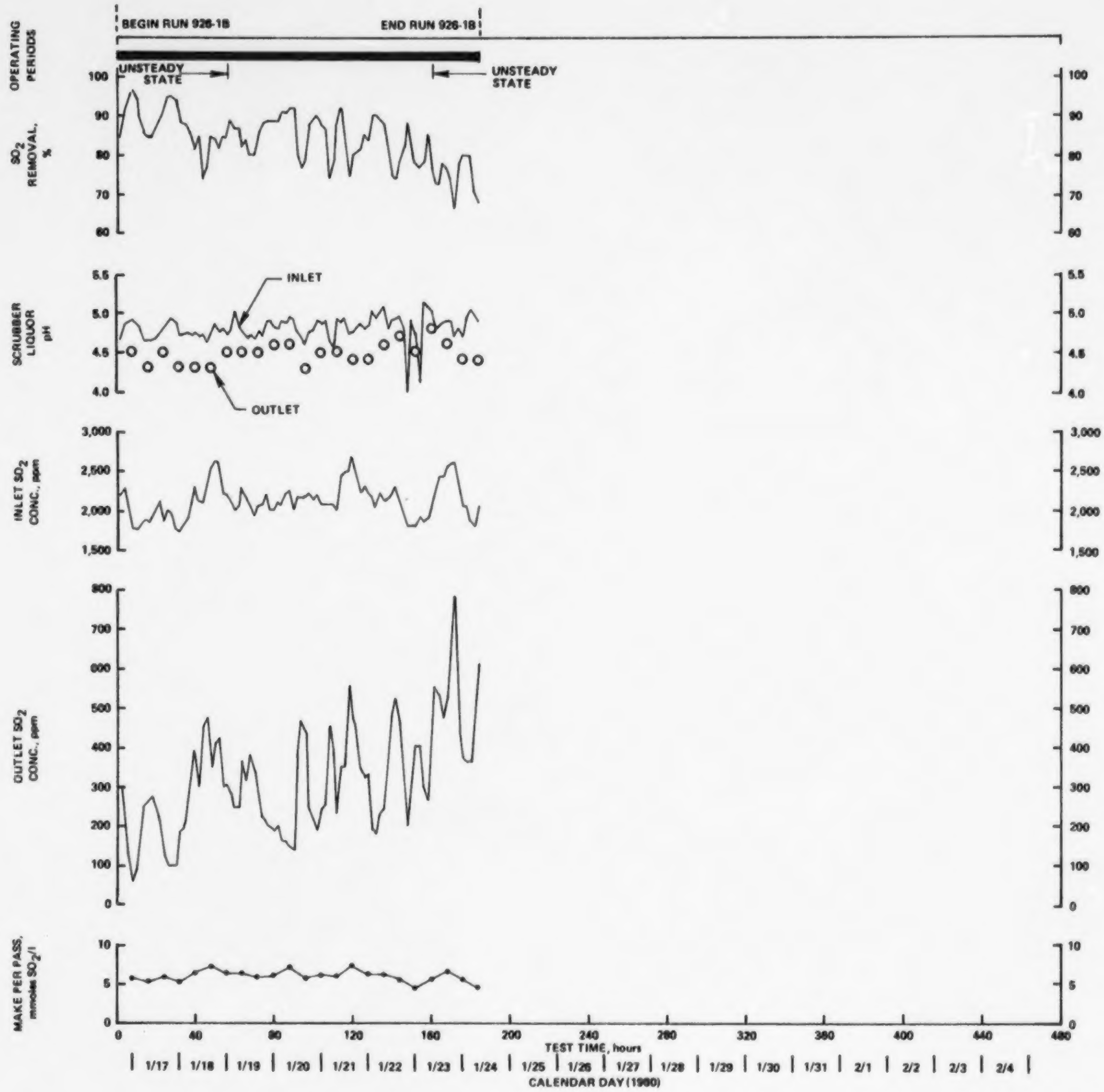
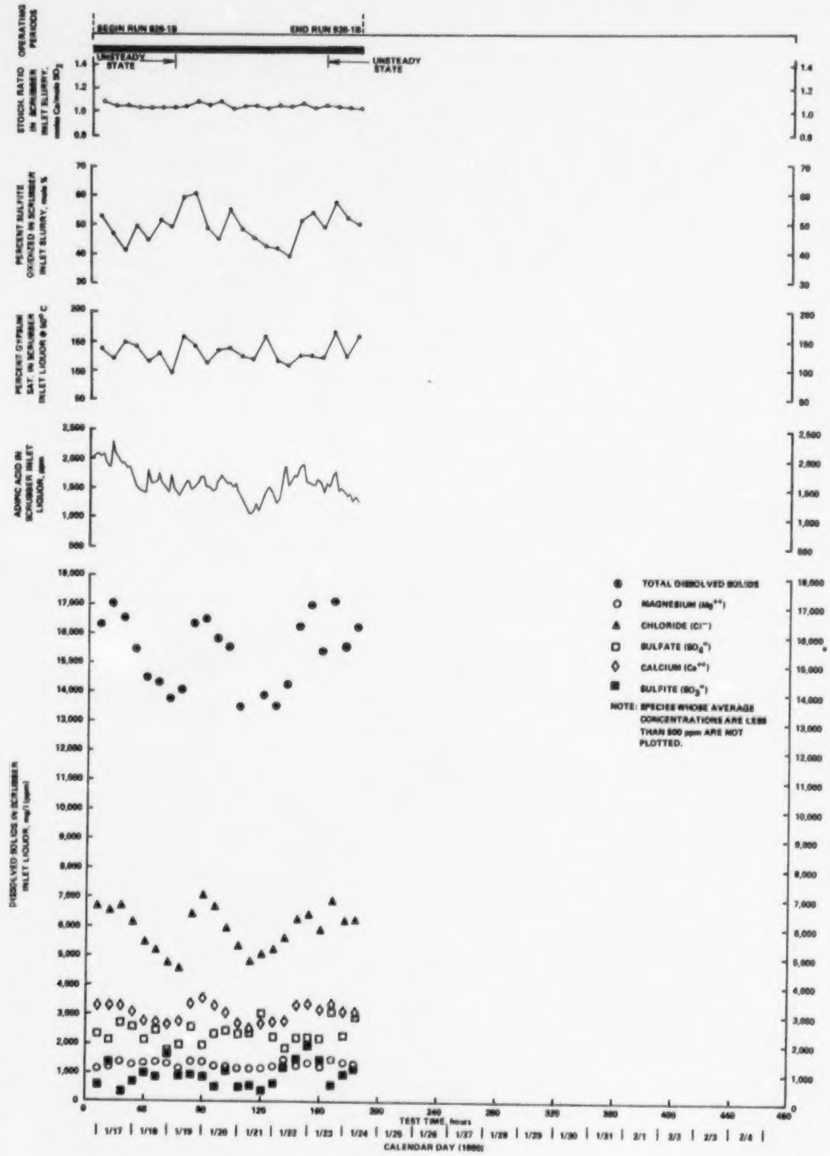


Figure F-33. Operating Data For Venturi/Spray Tower Run 926-1B



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time:
  Effluent Hold Tank = 9.1 min
Solids Recirculated, 13.4-16.4 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.3-16.3 in. H_2O
Mist Elim. Pressure Drop = 0.27-0.34 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
  Concentration = 67-73 wt %
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-33 (continued). Operating Data For Venturi/Spray Tower Run 926-1B

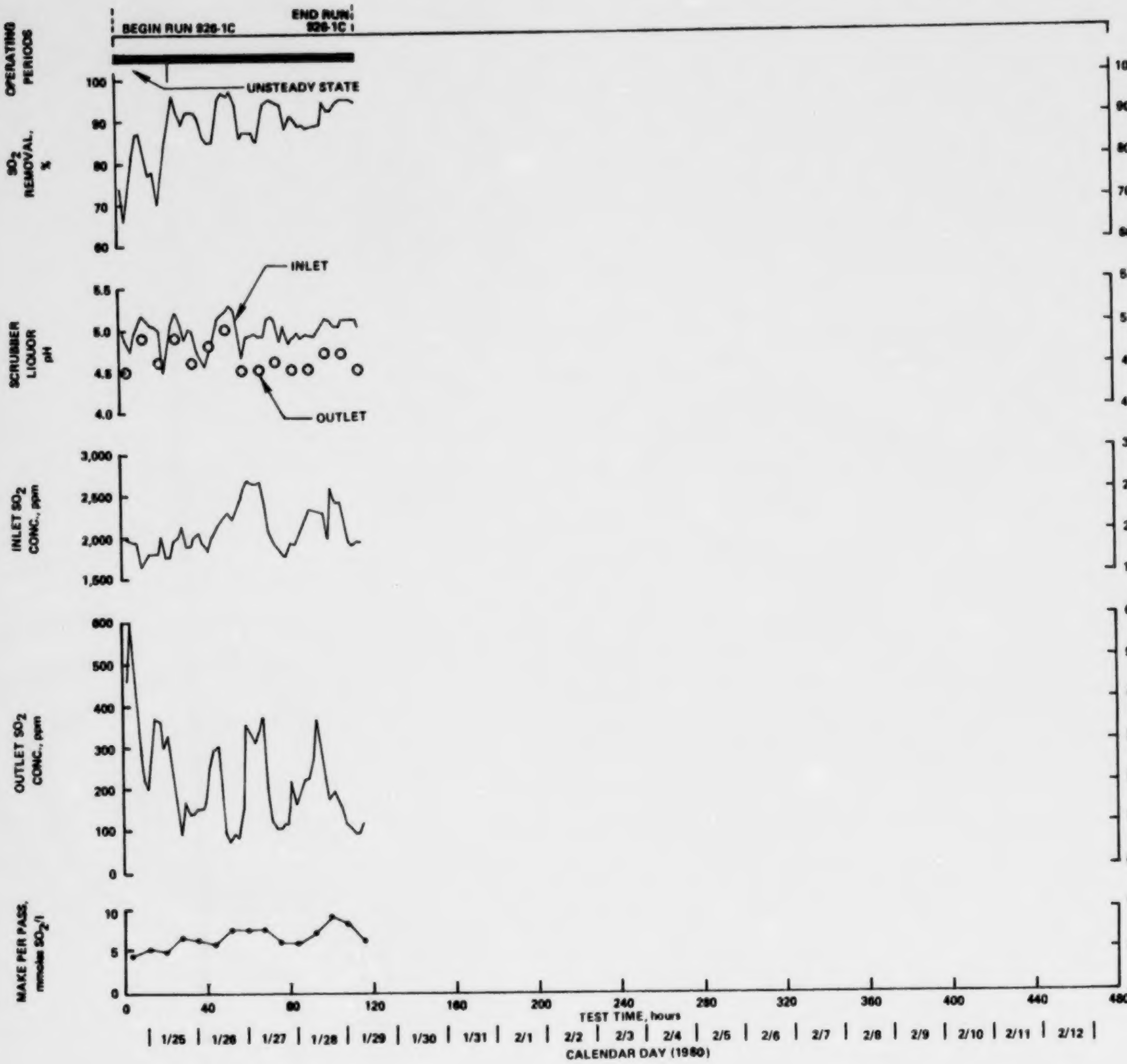
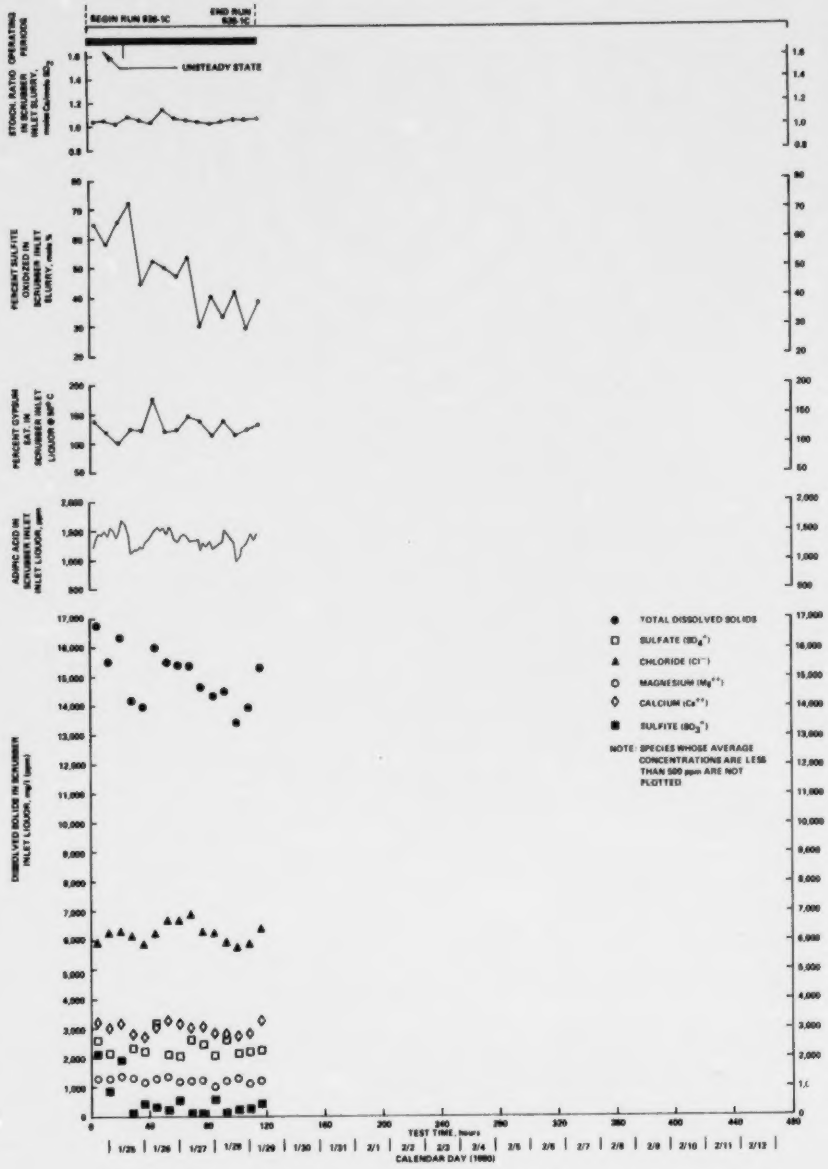


Figure F-34. Operating Data For Venturi/Spray Tower Run 926-1C



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time:
  Effluent Hold Tank = 9.1 min
Solids Recirculated, 14.2-16.0 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.1-16.5 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.33 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
  Concentration = 64-72 wt %
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-34 (continued). Operating Data For Venturi/Spray Tower Run 926-1C

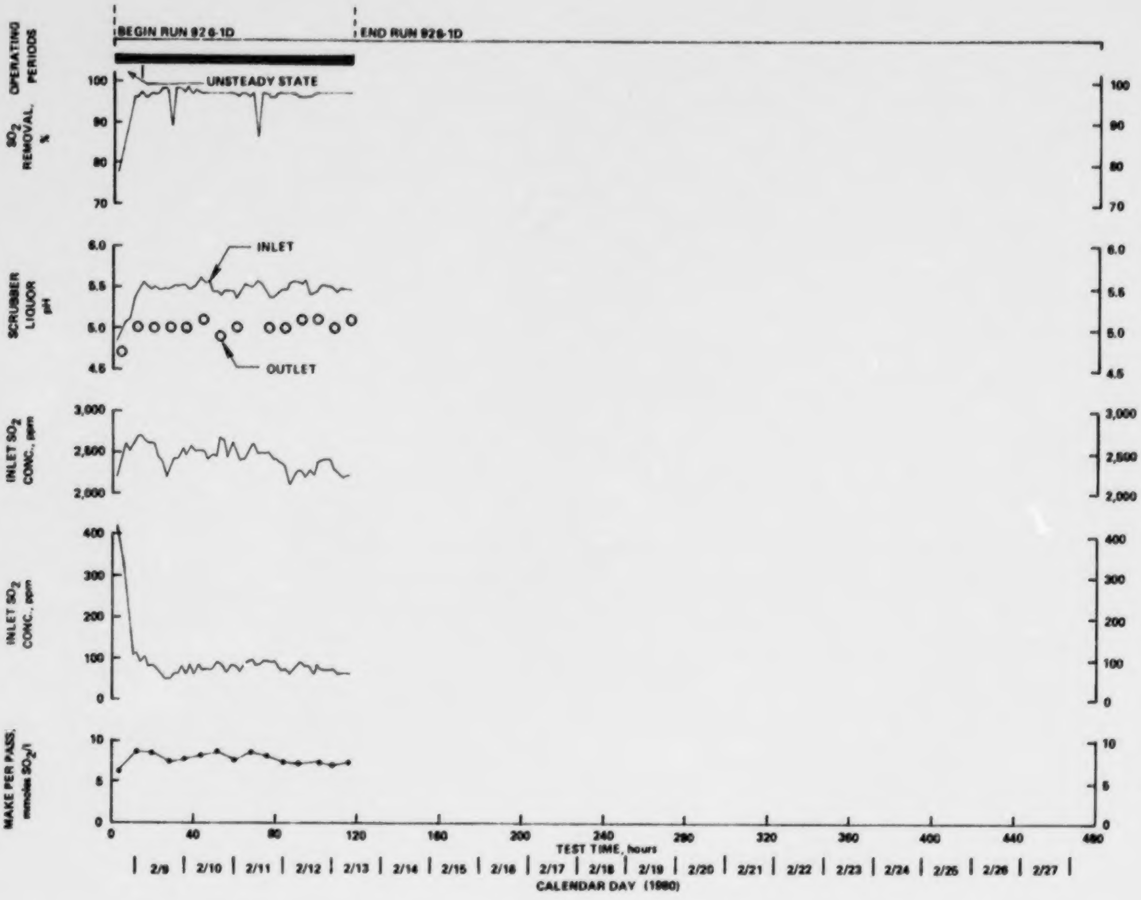
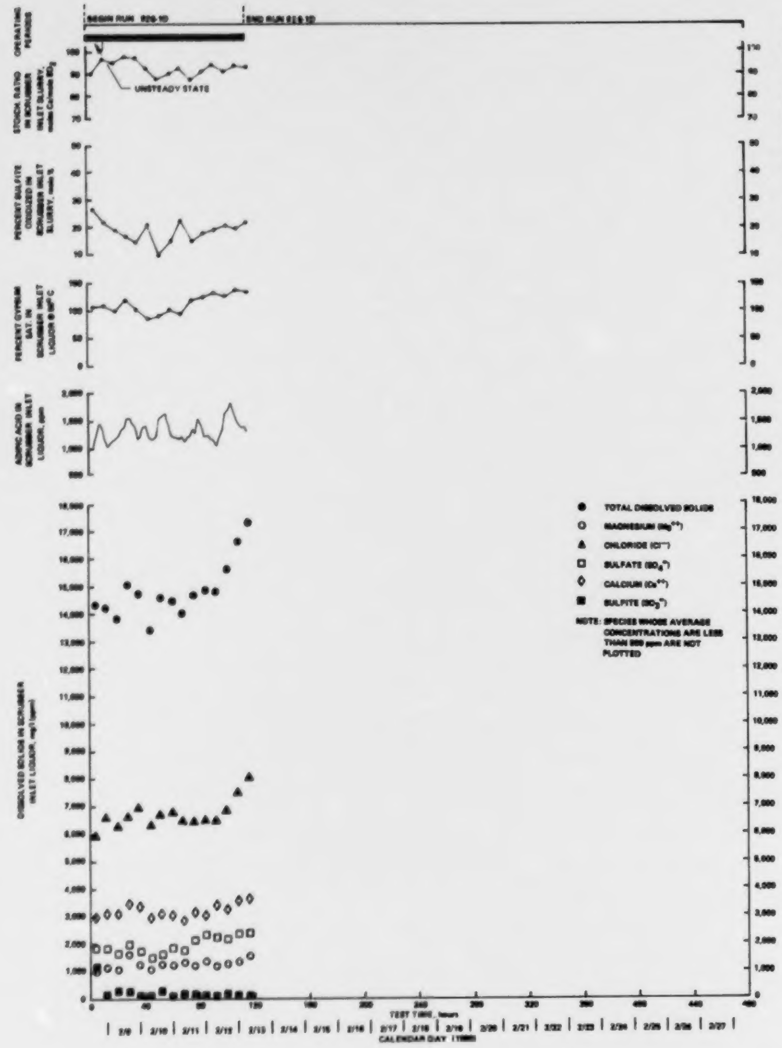


Figure F-35. Operating Data For Venturi/Spray Tower Run 926-1D



Gas Rate = 35,000 acfm @ 300 °F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125°F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Ventrui L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 9.1 min.
Percent Solids Recirculated = 14.6-16.4 % wt
Discharge (Clarifier and Centrifuge) = 54-68 % wt
Total Pressure Drop, Excluding Mist Elim. = 15.2-16.2 in. H_2O
Venturi Pressure Drop = 9 in. H_2O
Mist Elim. Pressure Drop = 0.25-0.32 in. H_2O
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-35 (continued). Operating Data For Venturi/Spray Tower Run 926-1D

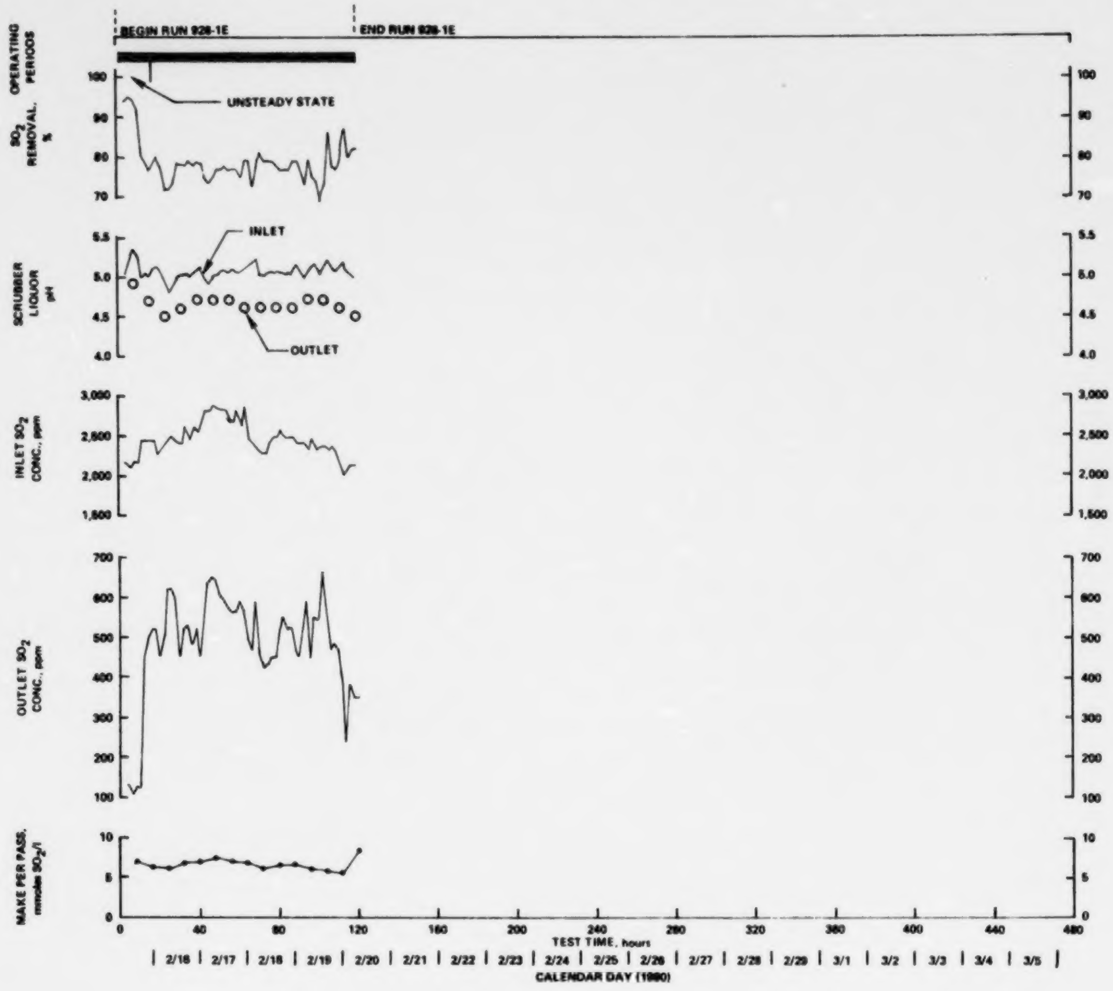
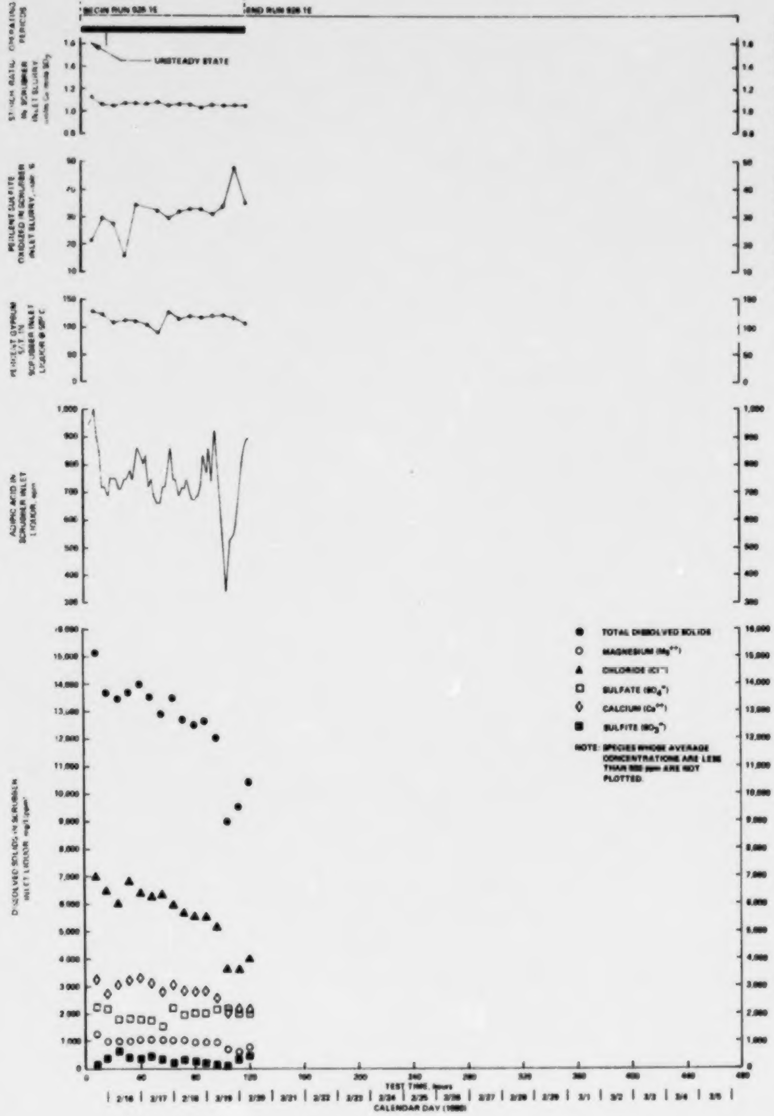


Figure F-36. Operating Data For Venturi/Spray Tower Run 926-1E



Gas Rate = 35,000 acfm @ 300 °F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125 °F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 9.1 min.
Percent Solids Recirculated = 14.0-16.4 % wt
Discharge (Clarifier and Centrifuge) = 55-65 % wt
Total Pressure Drop, Excluding Mist Elim. = 14.9-17.1 in. H_2O
Venturi Pressure Drop = 9 in. H_2O
Mist Elim. Pressure Drop = 0.26-0.32 in. H_2O
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-36 (continued). Operating Data For Venturi/Spray Tower Run 926-1E

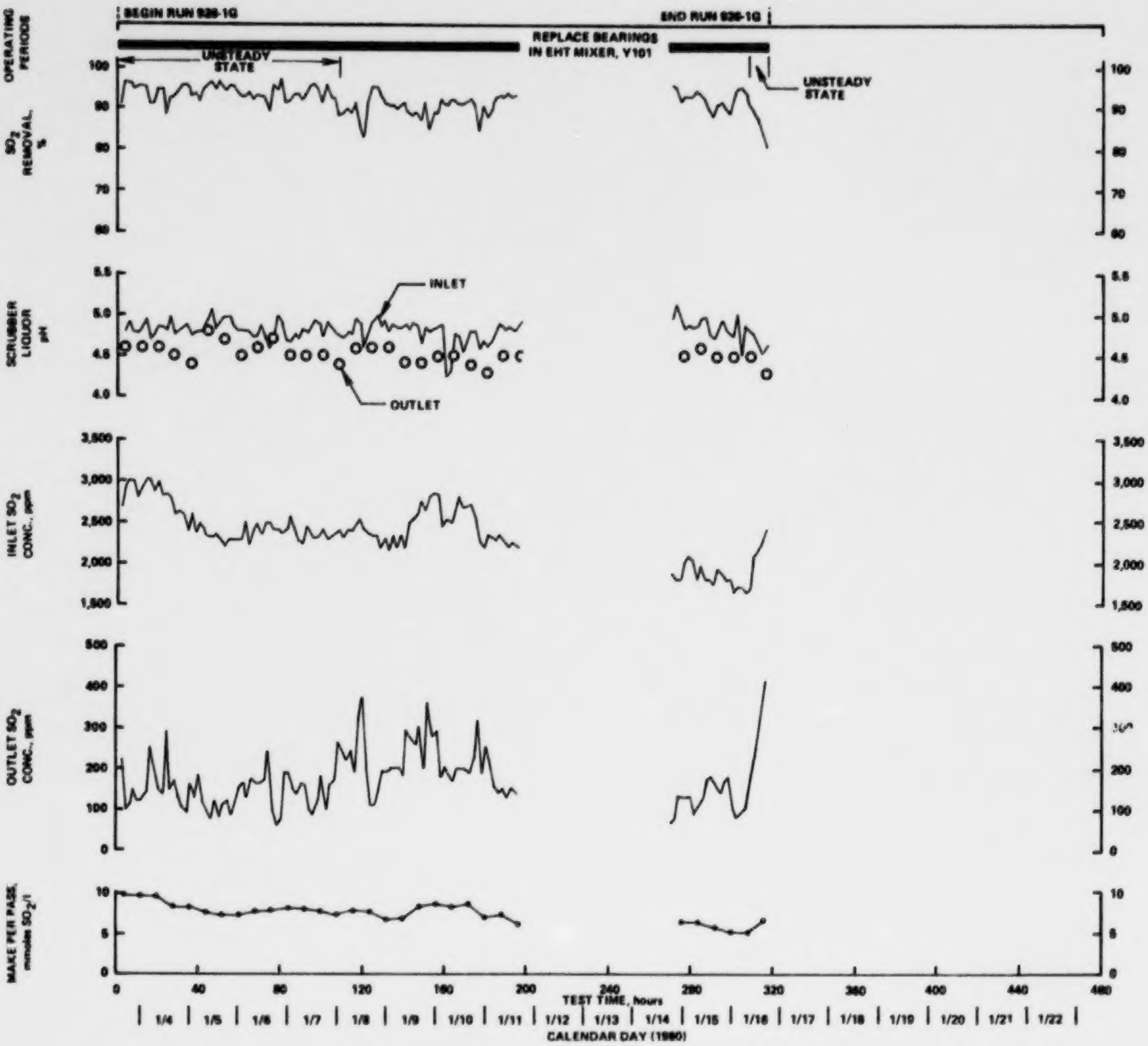
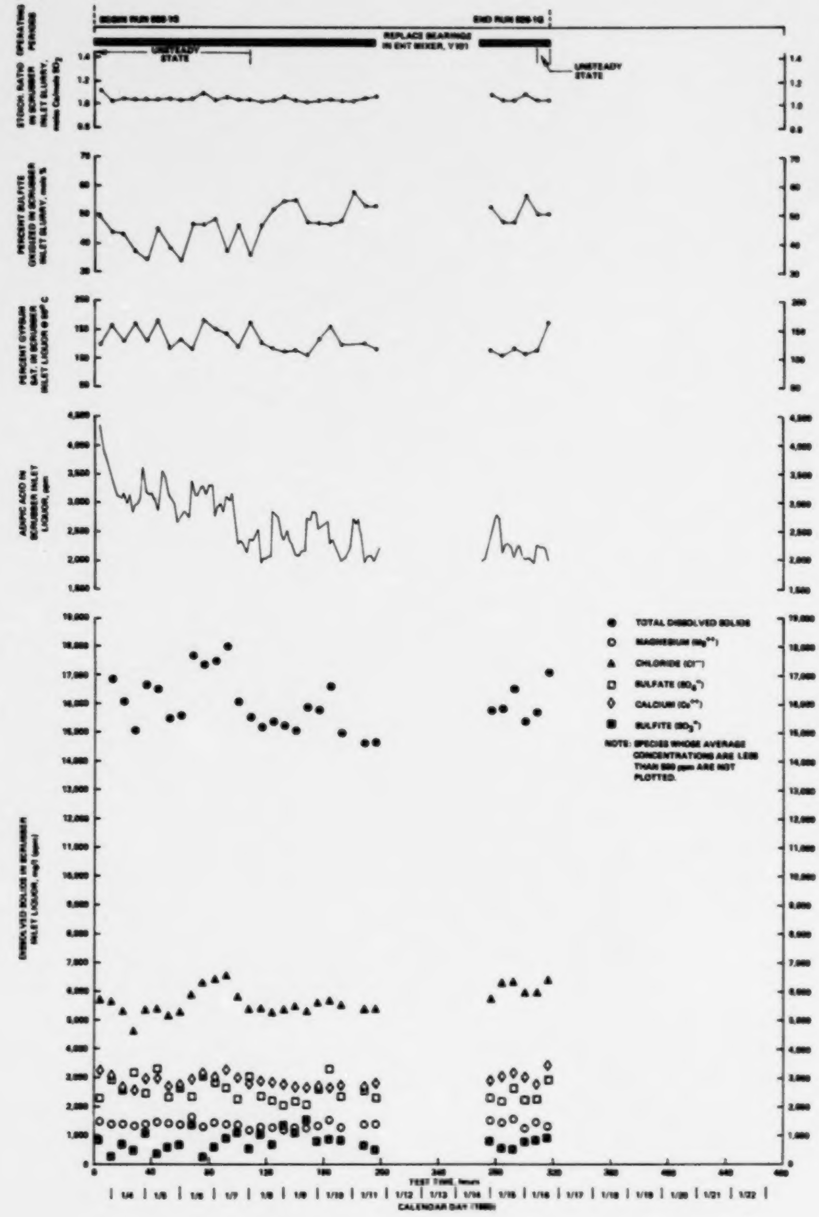


Figure F-37. Operating Data For Venturi/Spray Tower Run 926-1G



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time:
  Effluent Hold Tank = 9.1 min
Solids Recirculated, 13.3-16.9 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 14.3-15.5 in. H_2O
Mist Elim. Drop = 0.24- 0.36 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
  Concentration = 65-75 wt %
Limestone Addition to EHT
Adipic acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-37 (continued). Operating Data For Venturi/Spray Tower Run 926-1G

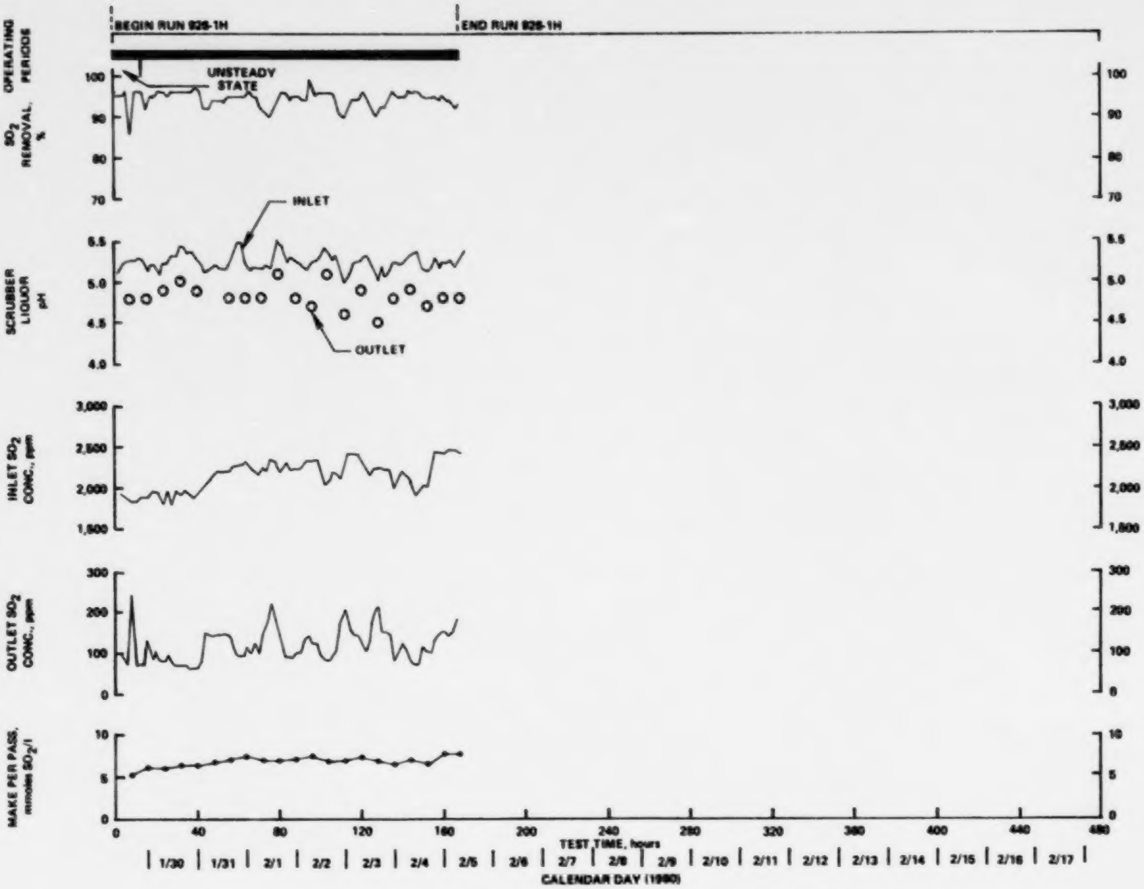
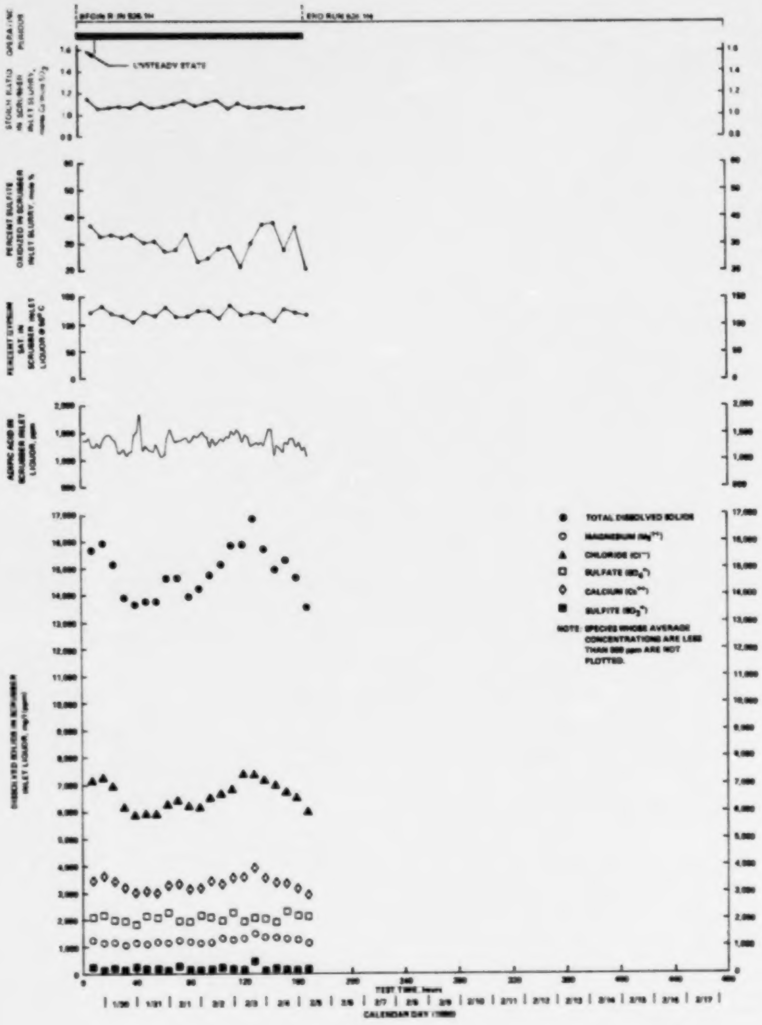


Figure F-38. Operating Data For Venturi/Spray Tower Run 926-1H



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec = @ 125 °F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Time of EHT = 9.1 min.
Percent Solids Recirculated = 13.7-16.1 % wt
Discharge (Clarifier and Centrifuge) = 56-70 % wt
Total Pressure Drop, Excluding Mist Elim. = 14.4-17.0 in. H_2O
Venturi Pressure Drop = 9 in. H_2O
Mist Elim. Pressure Drop = 0.26-0.30 in. H_2O
Limestone Addition to EHT
Adipic Acid Fed to EHT
Clarified Liquor Returned to EHT

Figure F-38 (continued). Operating Data For Venturi/Spray Tower Run 926-1H

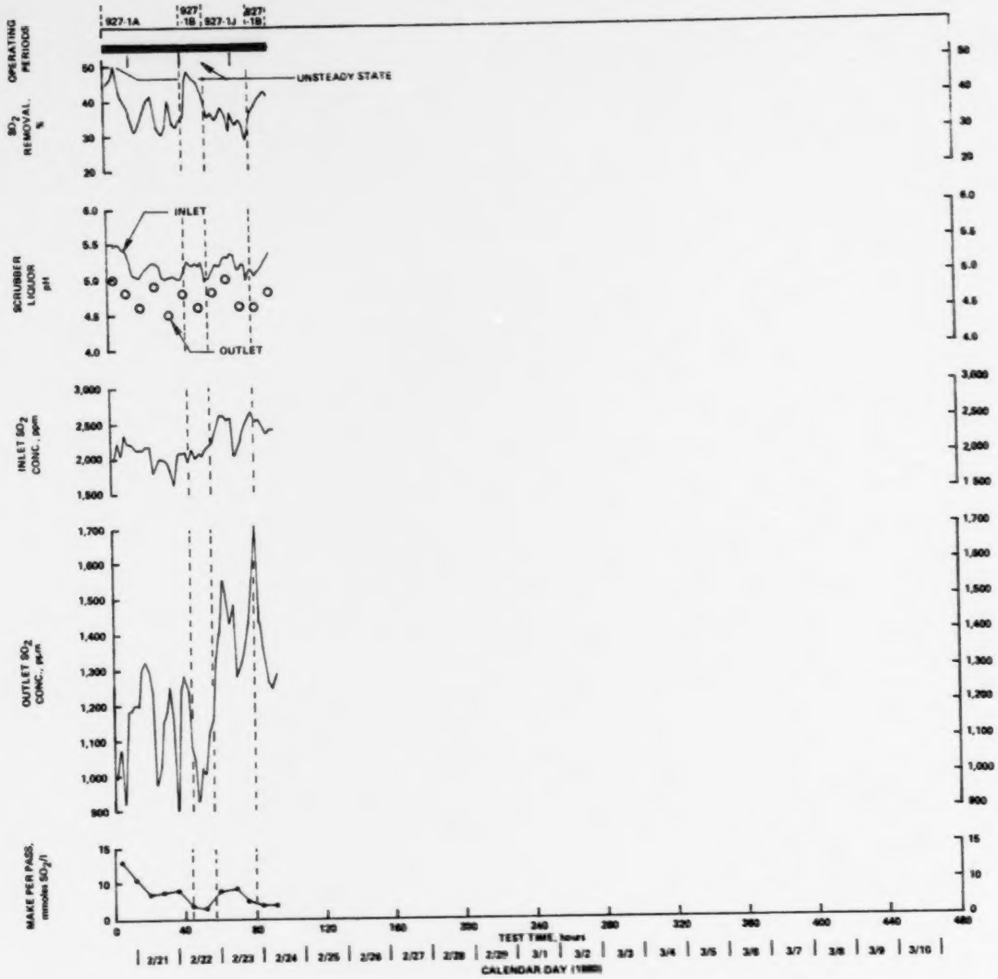
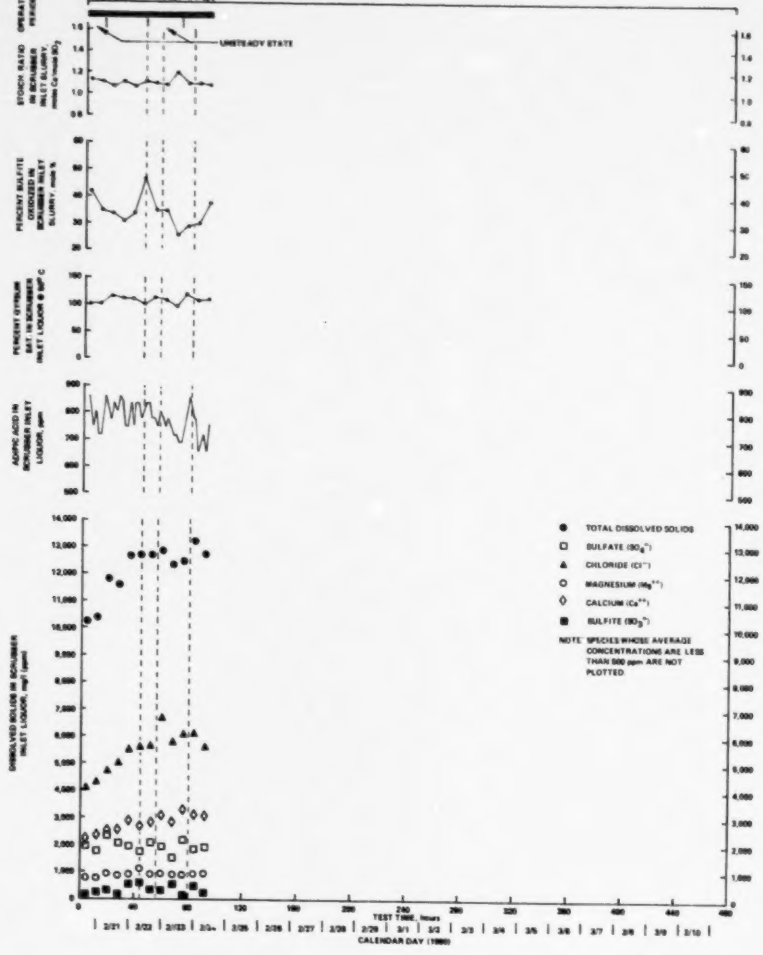


Figure F-39. Operating Data For Venturi Runs 927-1A,927-1B And 927-1J



927-1A

Gas Rate = 35,000 acfm @ 300°F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 21 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 13.6-15.6 % wt
Discharge (Clarifier and Centrifuge) = 63-67 % wt
Total Pressure Drop, Excluding Mist Elim. = 13.9-14.8 in. H_2O
Venturi Pressure Drop = 8.2 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.32 in. H_2O

927-1B

Gas Rate = 20,000 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 37 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 14.3-14.7 % wt
Discharge (Clarifier and Centrifuge) = 67 % wt
Total Pressure Drop, Excluding Mist Elim. = 7.5-7.9 in. H_2O
Venturi Pressure Drop = 5.9 in. H_2O
Mist Elim. Pressure Drop = 0.10-0.11 in. H_2O

927-1J

Gas Rate = 27,500 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 27 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 14.6 % wt
Discharge (Clarifier and Centrifuge) = 68 % wt
Total Presusure Drop, Excluding Mist Elim. = 9.2-9.4 in. H_2O
Venturi Pressure Drop = 5.9 in. H_2O
Mist Elim. Pressure Drop = 0.17-0.18 in. H_2O

Common to all Runs

Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned toEHT

Figure F-39 (continued). Operating Data For Venturi Runs 927-1A, 927-1B And 927-1J

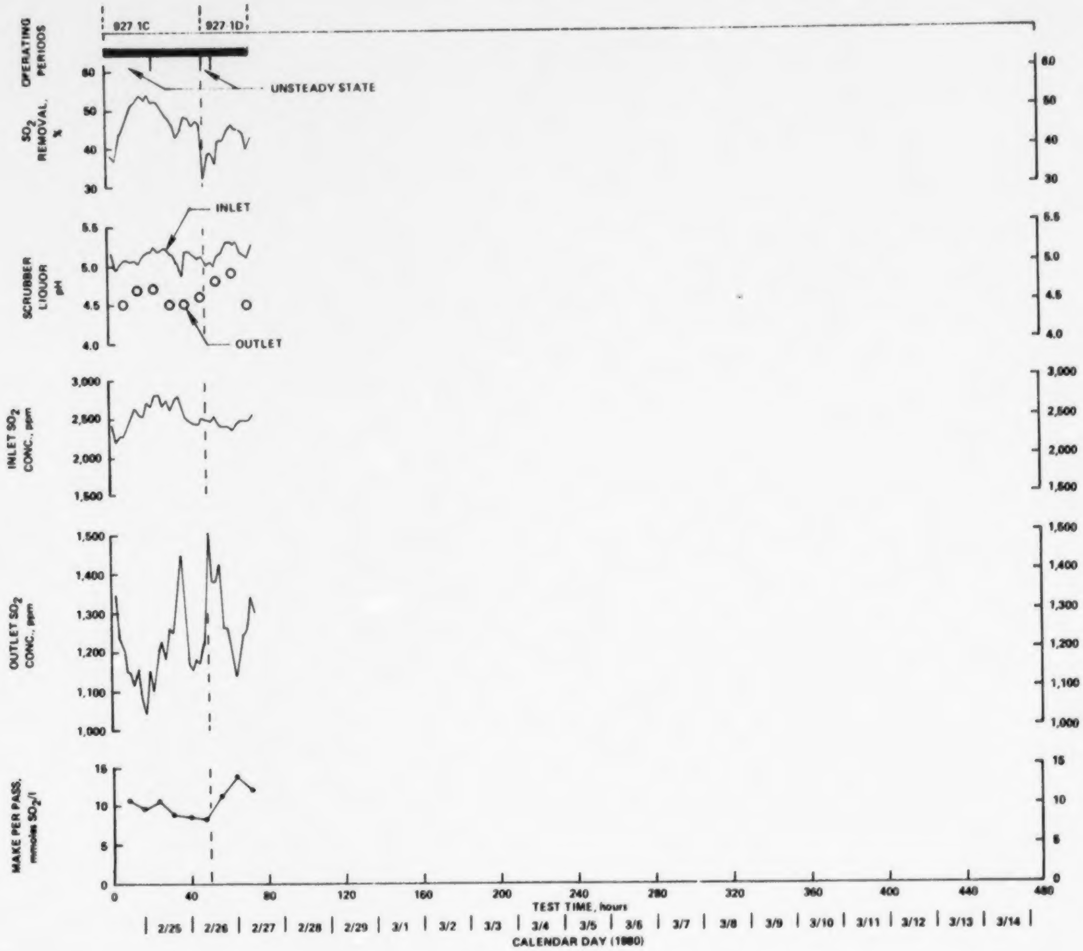
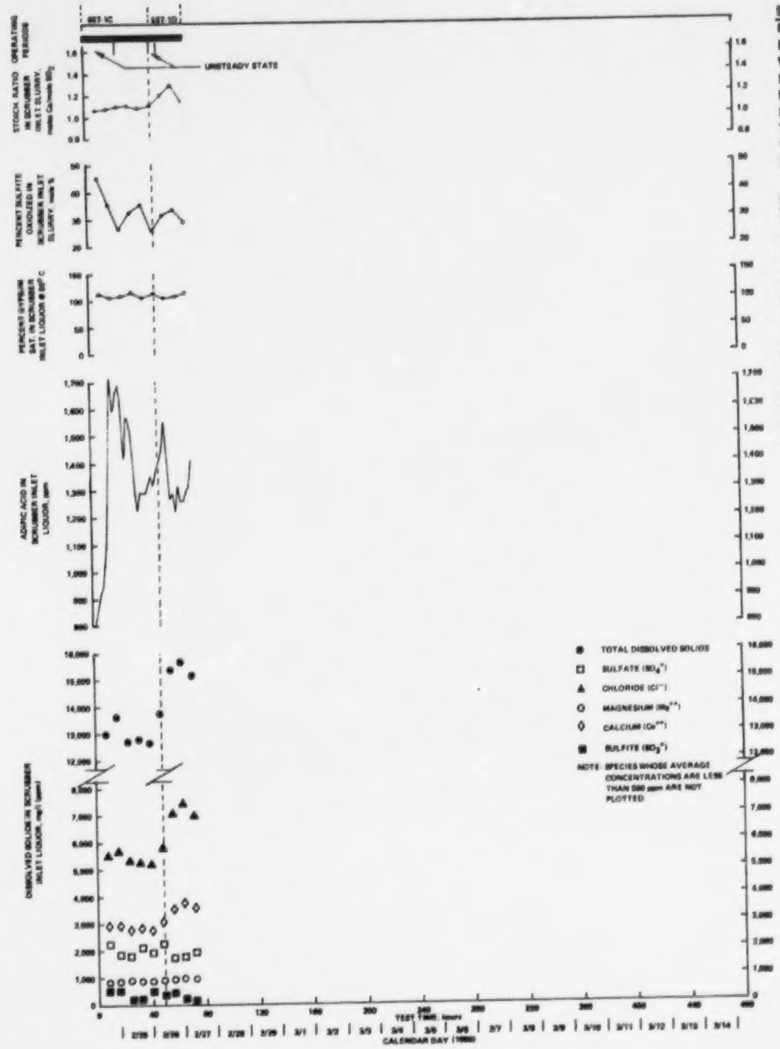


Figure F-40. Operating Data For Venturi Runs 927-1C And 927-1D

F



927-1C

Gas Rate = 20,000 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 37 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 13.8-14.3 % wt
Discharge (Clarifier and Centrifuge) = 63-65 % wt
Total Pressure Drop, Excluding Mist Elim. = 7.8-8.4 in. H_2O
Venturi Pressure Drop = 6.0 in. H_2O
Mist Elim. Pressure Drop = 0.05-0.10 in. H_2O

927-1D

Gas Rate = 35,000 acfm @ 300 °F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 21 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 15.7-16.9 % wt
Discharge (Clarifier and Centrifuge) = 67-70 % wt
Total Pressure Drop, Excluding Mist Elim. = 14.3-14.6 in. H_2O
Venturi Pressure Drop = 8.4 in. H_2O
Mist Elim. Pressure Drop = 0.24-0.26 in. H_2O

Common to Both Runs

Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-40 (continued). Operating Data For Venturi Runs 927-1C And 927-1D

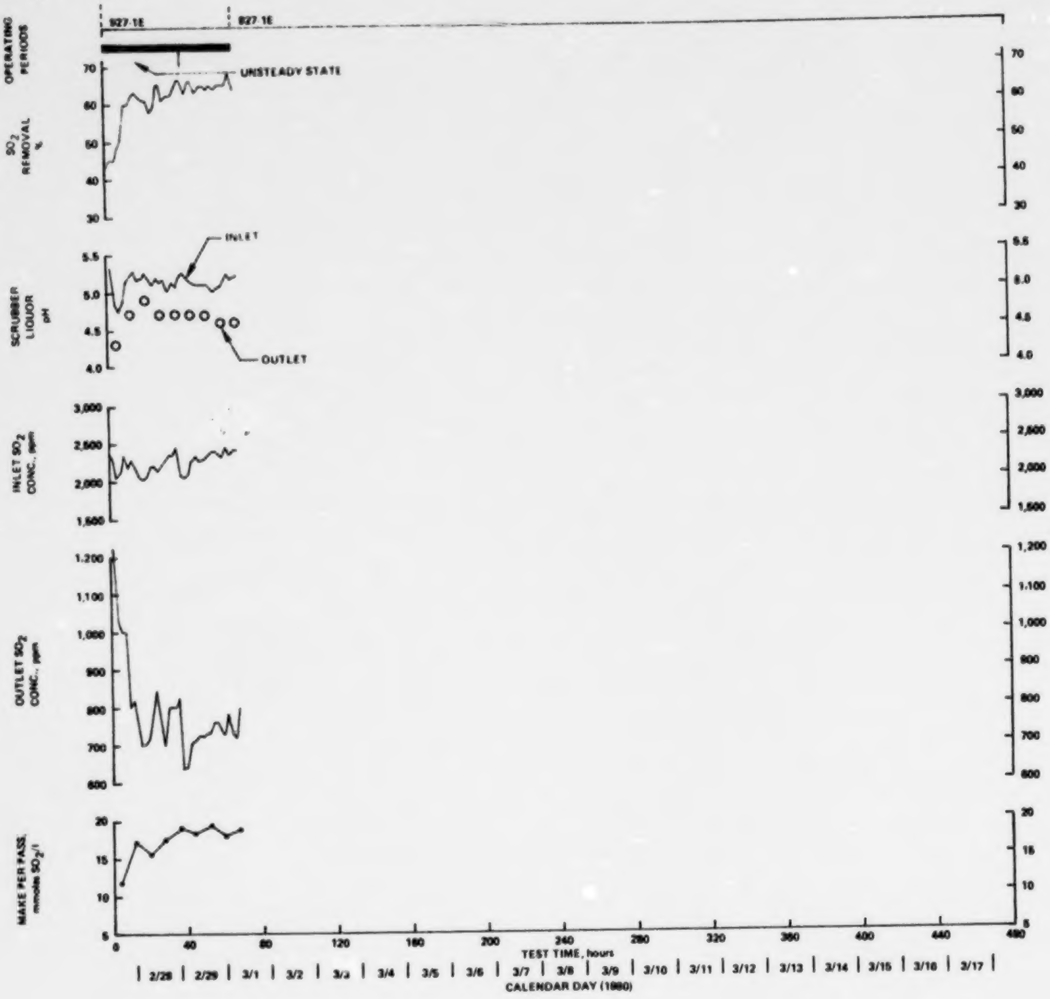
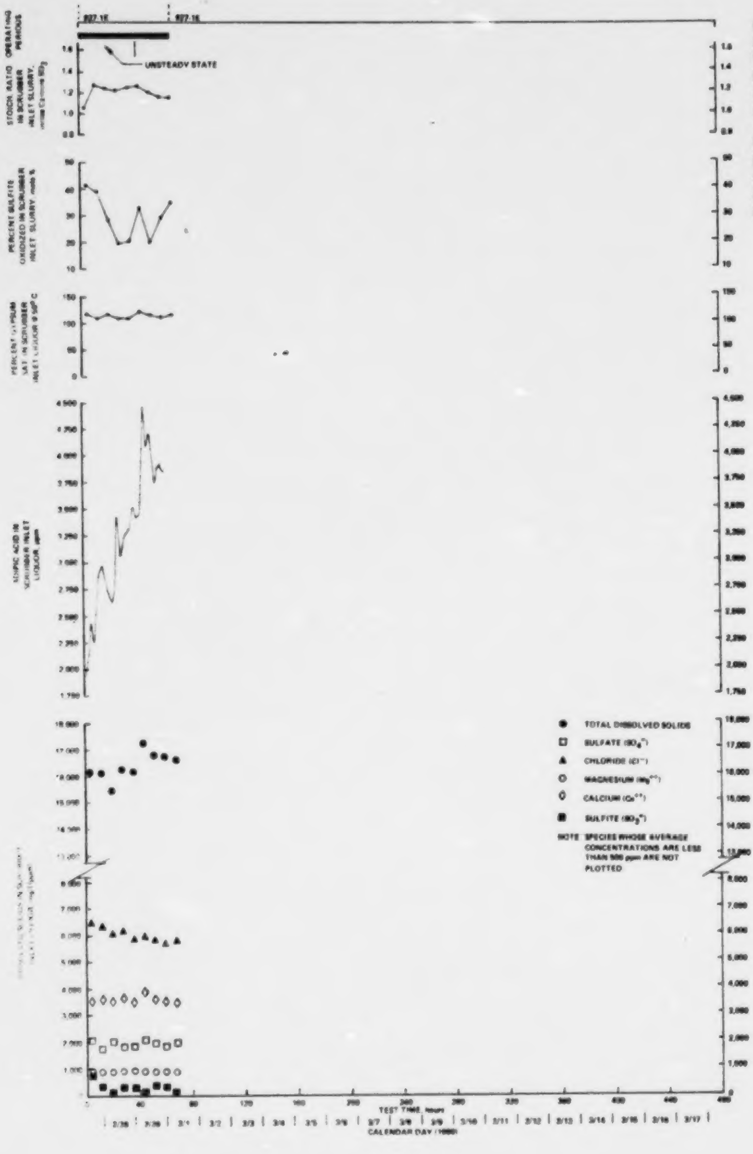


Figure F-41. Operating Data For Venturi Run 927-1E



Gas Rate = 35,000 acfm @ 300 ° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 21 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 14.9-15.8 % wt
Discharge (Clarifier and Centrifuge) = 59-63 % wt
Total Pressure Drop, Excluding Mist Elim. = 13.7-14.9 in. H_2O
Venturi Pressure Drop = 8.3 in. H_2O
Mist Elim. Pressure Drop = 0.23-0.27 in. H_2O
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-41 (continued). Operating Data For Venturi Run 927-1E

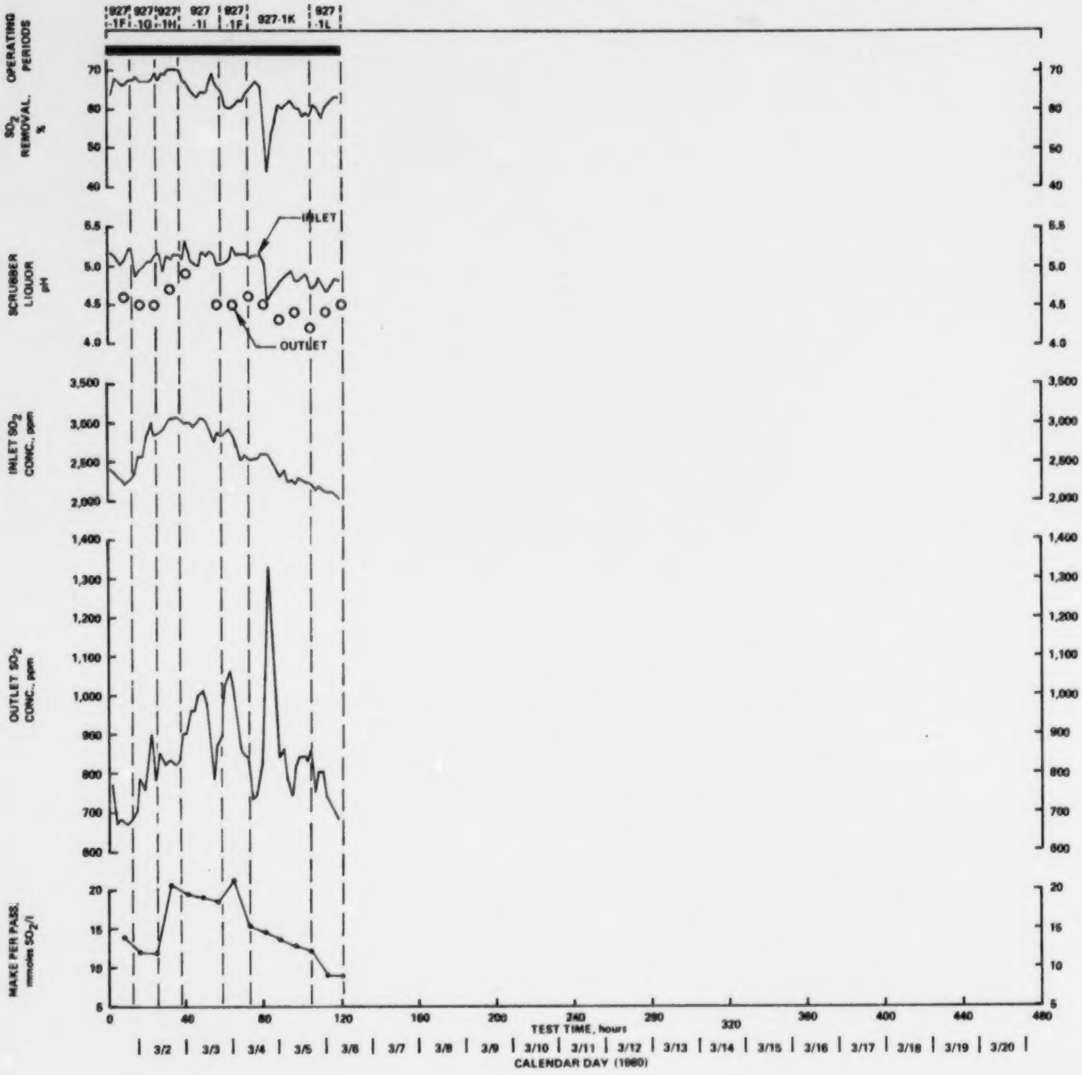
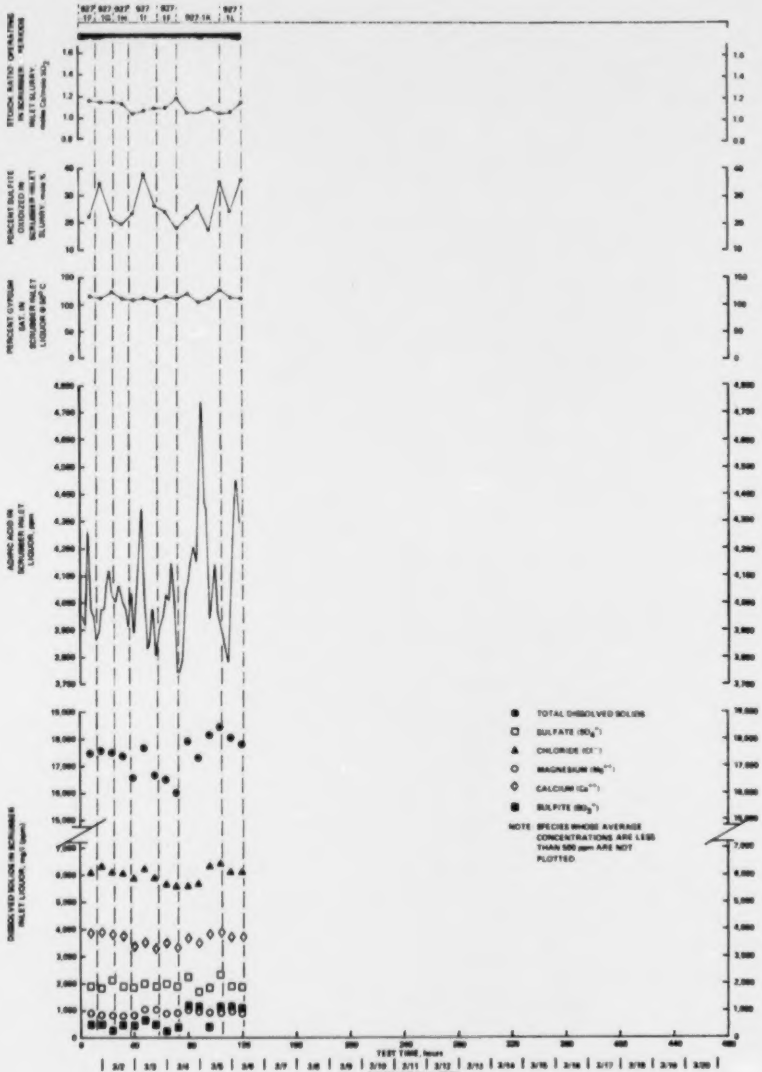


Figure F-42. Operating Data For Venturi Runs 927-1F, 927-1G, 927-1H, 927-1I, 927-1F, 927-1K And 927-1L



927-1F
Gas Rate = 27,500 acfm @ 300 °F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 27 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 15.3 % wt
Discharge (Clarifier and Centrifuge) = 63 % wt
Total Pressure Drop, Excluding Mist Elim. = 9.8-10.0 in. H_2O
Venturi Pressure Drop = 5.8-6.0 in. H_2O
Mist Elim. Pressure Drop = 0.13-0.15 in. H_2O

927-1G
Gas Rate = 20,000 acfm @ 300°F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 37 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 14.3 % wt
Discharge (Clarifier and Centrifuge) = 63 % wt
Total Pressure Drop, Excluding Mist Elim. = 7.9-8.3 in. H_2O
Venturi Pressure Drop = 5.9-6.1 in. H_2O
Mist Elim. Pressure Drop = 0.05-0.07 in. H_2O

927-1H
Gas Rate = 27,500 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 27 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 15.0 % wt
Discharge (Clarifier and Centrifuge) = 63 % wt
Total Pressure Drop, Excluding Mist Elim. = 12.2-12.8 in. H_2O
Venturi Pressure Drop 8.6-8.9 in. H_2O
Mist Elim. Pressure Drop = 0.15-0.17 in. H_2O

927-1I
Gas Rate = 27,500 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 27 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 15.0-15.6 % wt
Discharge (Clarifier and Centrifuge) = 62-63 % wt
Total Pressure Drop, Excluding Mist Elim. = 14.6-15.2 in. H_2O
Venturi Pressure Drop = 11.0-11.2 in. H_2O
Mist Elim. Pressure Drop = 0.15-0.18 in. H_2O

927-1K
Gas Rate = 27,500 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 27 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 14.3 - 15.2 % wt
Discharge (Clarifier and Centrifuge) = 63-67 % wt
Total Pressure Drop, Excluding Mist Elim. 12.1-12.6 in. H_2O
Venturi Pressure Drop = 8.6-8.9 in. H_2O
Mist Elim. Pressure Drop = 0.17-0.19 in. H_2O

927-1L
Gas Rate = 20,000 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 37 gal/Mcf
Residence Time of EHT = 33.4 min.
Percent Solids Recirculated = 13.0-14.1 % wt
Discharge (Clarifer and Centrifuge) = 66-69 % wt
Total Pressure Drop, Excluding Mist Elim. = 8.2-8.6 in. H_2O
Venturi Pressure Drop = 6.0-6.4 in. H_2O
Mist Elim. Pressure Drop = 0.07-0.09 in. H_2O

COMMON TO ALL RUNS
Limestone Addition to EHT
Adipic Acid Dry Fed to EHT
Clarified Liquor Returned to EHT

Figure F-42 (continued). Operating Data For Venturi Runs 927-1F, 927-1G, 927-1H, 927-1I, 927-1F, 927-1K And 927-1L

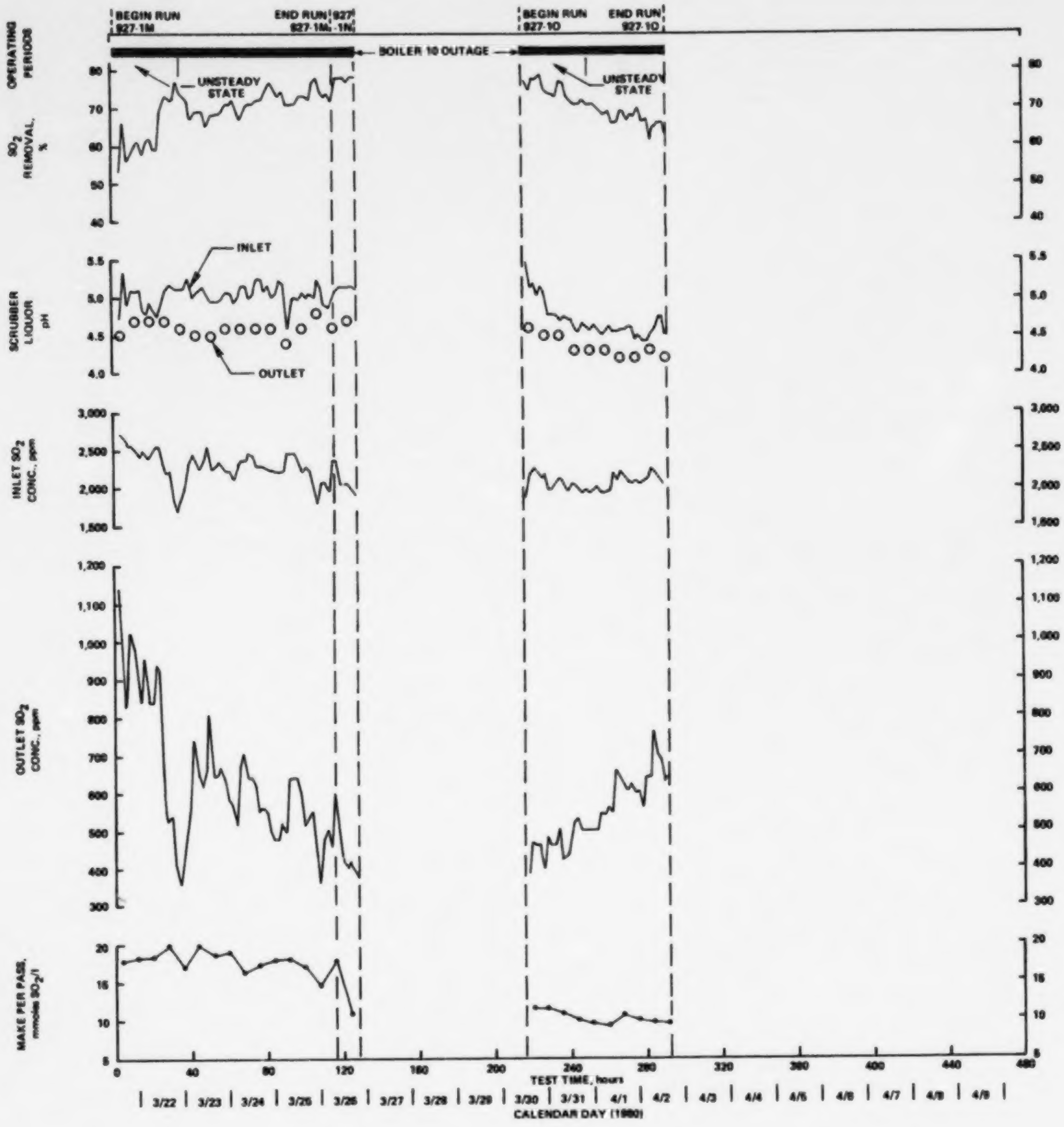
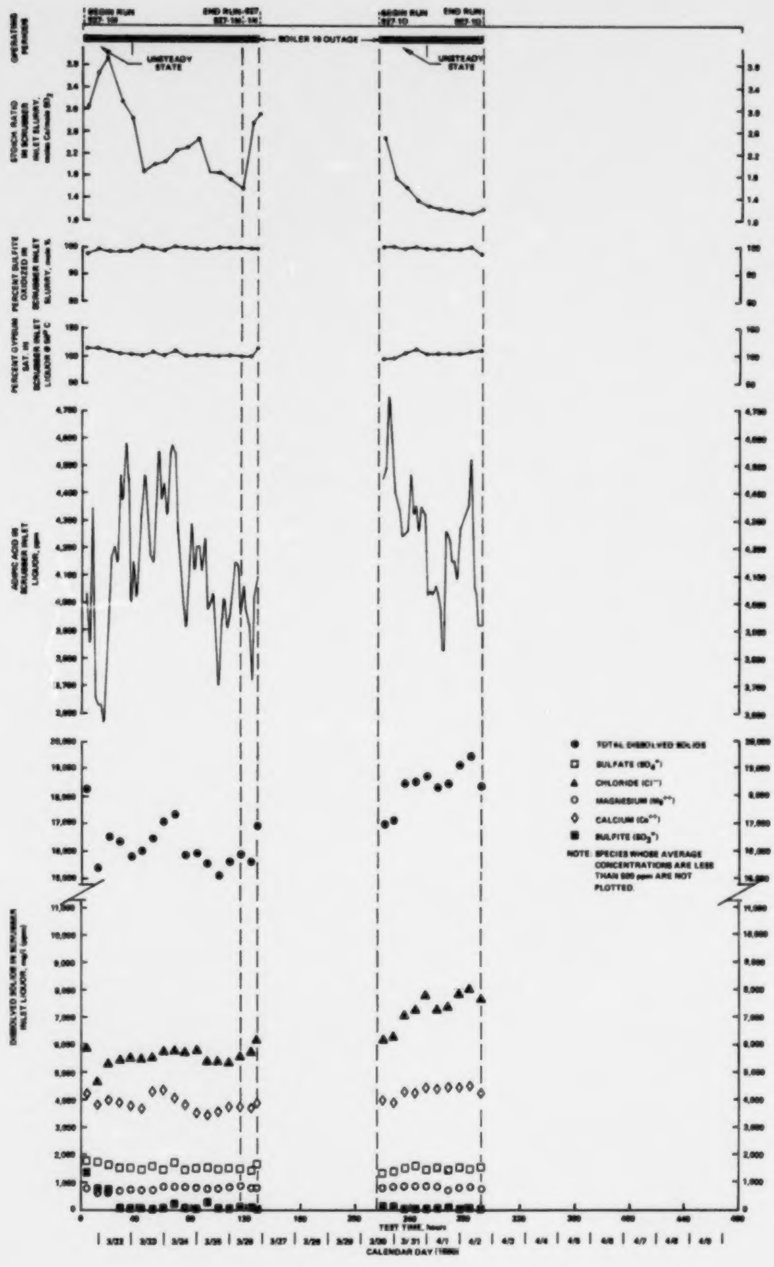


Figure F-43. Operating Data For Venturi Runs 927-1M, 927-1N And 927-1O



927-1M
Gas Rate = 30,000 acfm 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 25 gal/Mcf
Residence Time of Oxidation Tank = 10.6 min.
Percent Solids Recirculated = 13.6-16.4 % wt
Discharge (Clarifier and Centrifuge) = 76-80 % wt
Total Pressure Drop, Excluding Mist Elim. = 13.0-13.6 in. H_2O
Venturi Pressure Drop = 8.7-9.3 in. H_2O
Mist Elim. Pressure Drop = 0.21-0.25 in. H_2O
Air Flow to Oxidizer = 200 scfm
Oxidation Tank Agitator Speed = 56 rpm

927-1N
Gas Rate = 20,000 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 37 gal/Mcf
Residence Time of Oxidation Tank = 10.6 min.
Percent Solids Recirculated = 14.9-15.9 % wt
Discharge (Clarifier and Centrifuge) = 79 % wt
Total Pressure Drop, Excluding Mist Elim. = 8.7-9.3 in. H_2O
Venturi Pressure Drop = 6.8-7.2 in. H_2O
Mist Elim. Pressure Drop = 0.11-0.13 in. H_2O
Air Flow to Oxidizer = 200 scfm
Oxidation Tank Agitator Speed = 56 rpm

927-1O
Gas Rate = 20,000 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 25 Gal/Mcf
Residence Time of Oxidation Tank = 10.6 min.
Percent Solids Recirculated = 13.7-16.3 % wt
Discharge (Clarifier and Centrifuge) = 77-79 % wt
Total Pressure Drop, Excluding Mist Elim. = 8.9-9.4 in. H_2O
Venturi Pressure Drop = 7.0-7.3 in. H_2O
Mist Elim. Pressure Drop = 0.12-0.16 in. H_2O
Air Flow to Oxidizer = 200 scfm
Oxidation Tank Agitator Speed = 56 rpm

COMMON TO ALL RUNS
Limestone Addition to Oxidation Tank
Adipic Acid Dry Fed to Oxidation Tank
Clarified Liquor Returned to Oxidation Tank

Figure F-43 (continued). Operating Data For Venturi Runs 927-1M, 927-1N And 927-1O

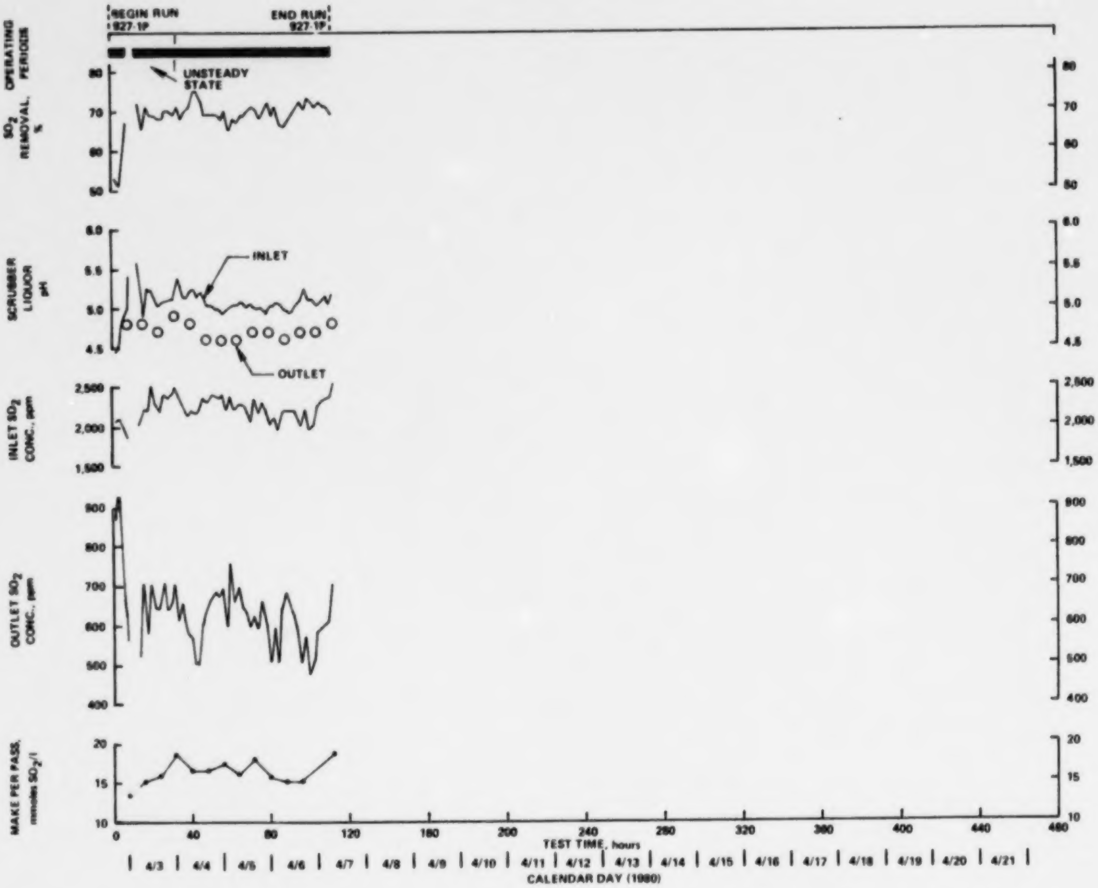
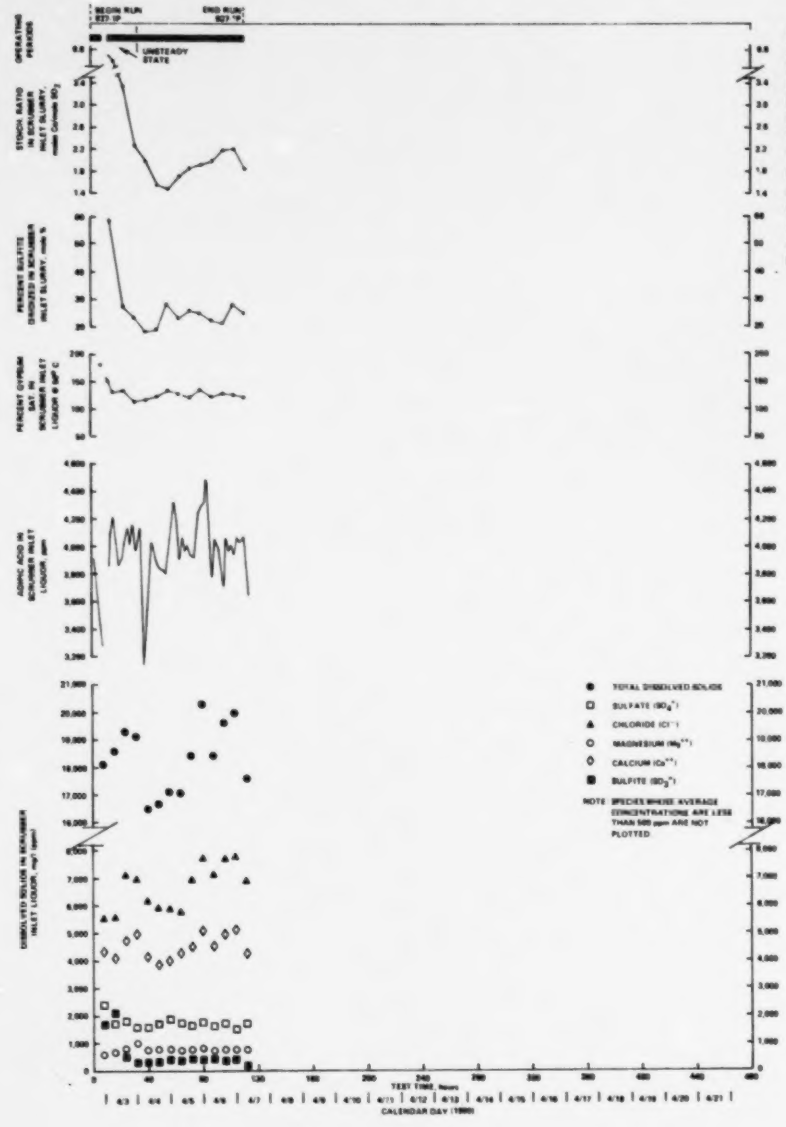
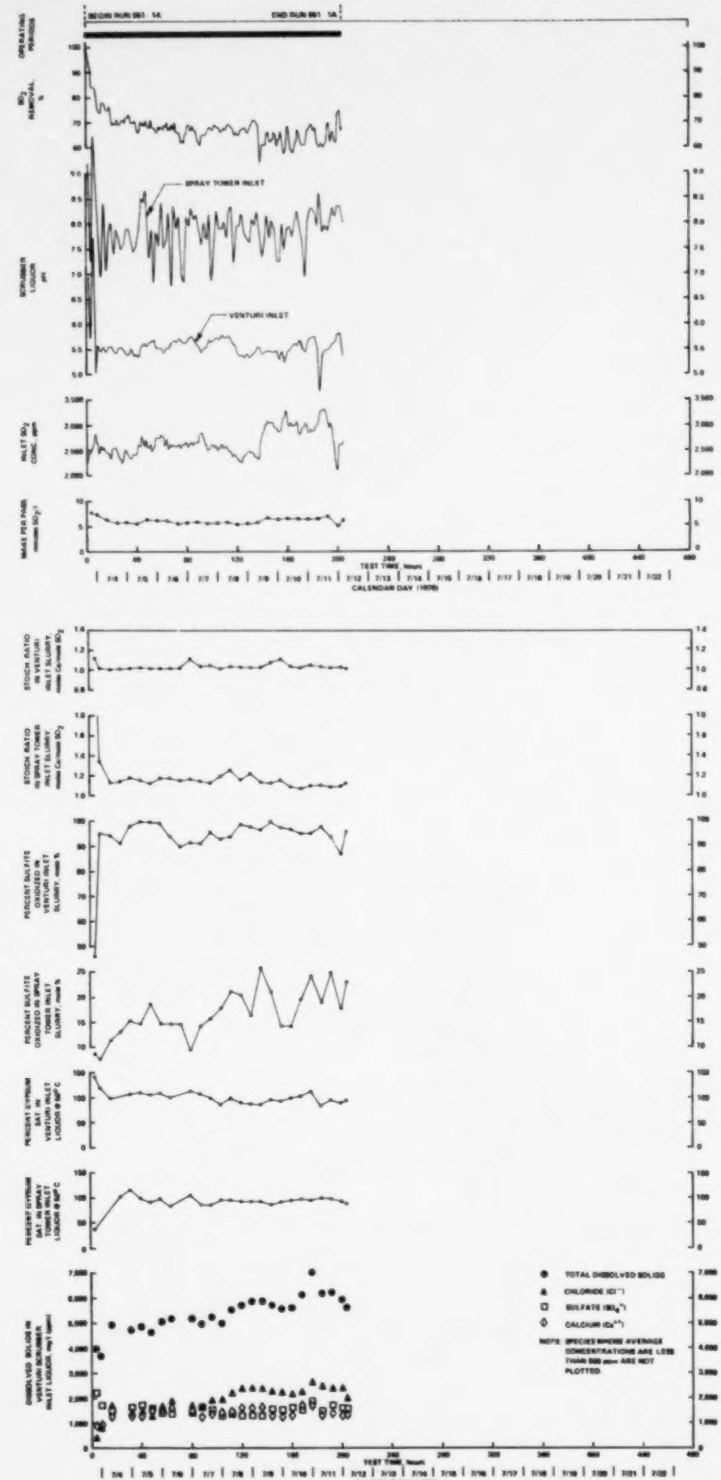


Figure F-44. Operating Data For Venturi Run 927-1P



Gas Rate = 30,000 acfm @ 300° F
Liquor Rate to Venturi = 600 gpm
Venturi L/G = 25 gal/Mcf
Residence Time of Oxidation Tank = 10.6 min.
Percent Solids Recirculated = 14.6-15.3 % wt
Discharge (Clarifier and Centrifuge) = 59-66 % wt
Total Pressure Drop, Excluding Mist Elim. 12.2-12.9 in. H_2O
Venturi Pressure Drop = 8.3-9.4 in. H_2O
Mist Elim. Pressure Drop = 0.21-0.25 in. H_2O
Air Flow to Oxidizer = none
Oxidation Tank Agitator Speed = 56 RPM
Limestone Addition to Oxidation Tank
Adipic Acid Dry Fed to Oxidation Tank
Clarified Liquor Returned to Oxidation Tank

Figure F-44 (continued). Operating Data For Venturi Run 927-1P



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 14.3 - 17.1 wt %
Solids Recirculated, Spray Tower Loop = 4.6 - 6.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 15.2 - 16.4 in. H_2O
Mist Elim. Pressure Drop = 0.60 - 0.66 in. H_2O
Air Flow Rate to Oxidizer = 210 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 82 - 89 wt %
Lime Addition to Venturi Downcomer and Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-45. Operating Data For Venturi/Spray Tower Run 951-1A

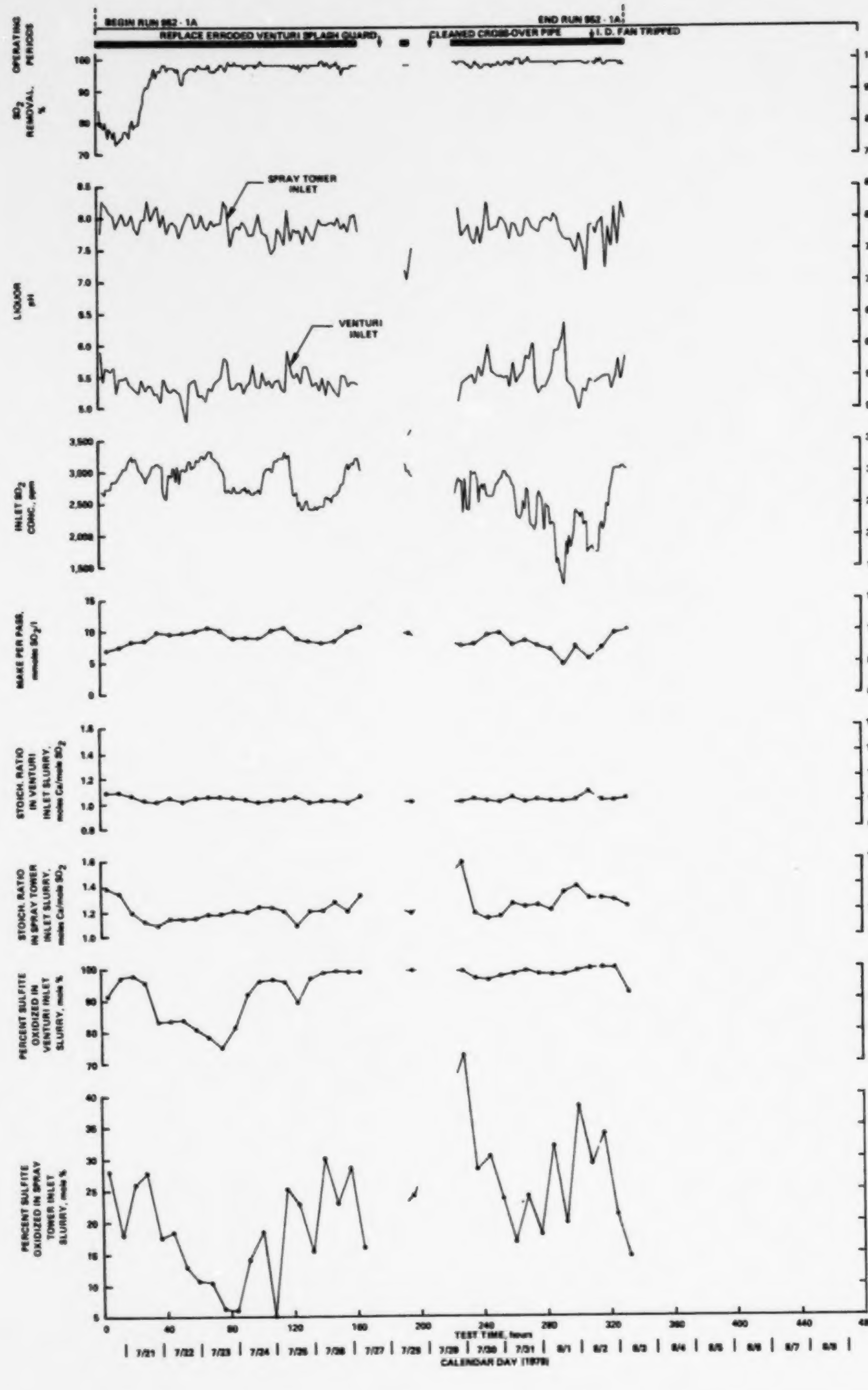
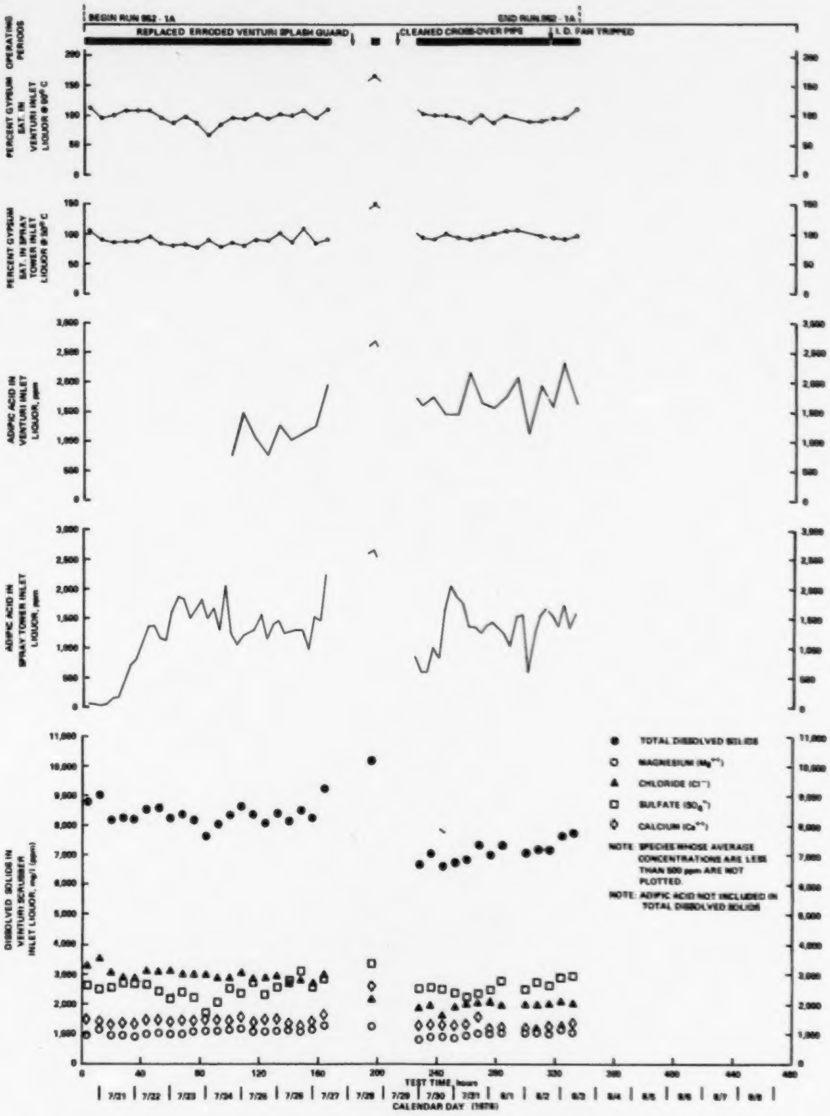


Figure F-46. Operating Data For Venturi/Spray Tower Run 952-1A



Gas Rate = 35,000 acfm @ 300° F
Spray Tower Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate to Venturi = 600 gpm
Liquor Rate to Spray Tower = 1600 gpm
Venturi L/G = 21 gal/Mcf
Spray Tower L/G = 57 gal/Mcf
No. of Spray Headers = 4
Residence Times:
  Spray Tower Hold Tank = 14.7 min
  Oxidation Tank = 11.3 min
  Desupersaturation Tank = 4.7 min
Solids Recirculated, Venturi Loop = 12.0 - 19.2 wt %
Solids Recirculated, Spray Tower Loop = 2.1 - 6.8 wt %
Venturi Pressure Drop = 9 in. H_2O
Total Pressure Drop, Excl. Mist Elim.
  = 13.9 - 17.4 in. H_2O
Mist Elim. Pressure Drop = 0.50 - 0.68 in. H_2O
Air Flow Rate to Oxidizer = 260 scfm
Discharge (Clarifier & Filter) Solids
  Concentration = 81 - 88 wt %
Lime Addition to Venturi Downcomer and Spray Tower EHT
Adipic Acid Dry Fed to Spray Tower EHT
Clarified Liquor Returned to Spray Tower EHT

Figure F-46 (continued). Operating Data For Venturi/Spray Tower Run 952-1A

APPENDIX G

AVERAGE LIQUOR COMPOSITIONS FOR THE VENTURI/SPRAY TOWER AND SPRAY TOWER TESTS

57X

The values in these tables are averages for steady-state operating periods.

Percent sulfite oxidized is measured in the bleed stream from the scrubber system.

Calculated Percent Gypsum Saturation = (activity Ca^{++}) x (activity $SO_4^{=}$) x 100/ (solubility product at 50°C).

Estimated solubility product for $CaSO_4 \cdot 2H_2O$ at 50°C is 2.2×10^{-5} (Reference 28).

Table G-1

AVERAGE LIQUOR COMPOSITIONS FOR VENTURI/SPRAY TOWER AND SPRAY TOWER-ONLY TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
827-1A	85	98	Venturi Inlet	5.50	875	970	65	80	65	3415	--	--	1665	--	7135	100	7.3
			Venturi Outlet	4.90	1115	970	65	80	770	3510	--	--	1650	--	8160	120	7.5
			Spray Tower Inlet	5.60	980	880	60	70	655	3115	--	--	1435	--	7195	100	8.0
			Spray Tower Outlet	--	965	855	60	70	730	2975	--	--	1420	--	7075	100	9.1
828-1A	84	98	Venturi Inlet	5.55	955	1190	70	75	115	3605	--	--	2620	--	8630	95	0.0
			Venturi Outlet	4.95	1110	1170	75	80	725	3325	--	--	2705	--	9190	100	1.2
			Spray Tower Inlet	5.65	1010	1060	75	80	545	3325	--	--	2330	--	8425	95	-0.5
			Spray Tower Outlet	--	965	1065	75	80	715	3230	--	--	2250	--	8380	95	0.5
828-1B	84	99	Venturi Inlet	5.25	1125	1505	100	170	45	3485	--	--	3595	--	10,025	95	7.6
			Venturi Outlet	4.80	1415	1510	100	155	395	3690	--	--	3550	--	10,815	115	10.4
			Spray Tower Inlet	5.00	1715	1320	95	150	2935	2945	--	--	2920	--	12,080	115	9.5
			Spray Tower Outlet	--	1555	1470	90	145	2500	2950	--	--	2830	--	11,540	105	16.1
829-1A	79	87	Venturi Inlet	5.55	1045	1590	115	175	170	3890	--	--	3265	--	10,250	95	9.6
			Venturi Outlet	4.95	1280	1540	120	180	935	3740	--	--	3260	--	11,055	105	9.0
			Spray Tower Inlet	5.75	1045	1405	100	155	425	3455	--	--	2935	--	9520	90	8.1
			Spray Tower Outlet	--	1045	1370	100	160	435	3410	--	--	2895	--	9415	90	8.5
830-1A	79	94	Venturi Inlet	6.00	960	1380	105	155	85	4130	--	--	2390	--	9205	100	8.9
			Venturi Outlet	5.30	1175	1345	105	155	715	4280	--	--	2420	--	10,195	120	5.7
			Spray Tower Inlet	6.10	925	1240	95	135	230	3675	--	--	2130	--	8430	90	10.9
			Spray Tower Outlet	--	920	1195	95	135	245	3715	--	--	2110	--	8415	95	7.5

Table G-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR VENTURI/SPRAY TOWER AND SPRAY TOWER-ONLY TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/1) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
901-1A	85	98	Venturi Inlet	4.50	1340	785	125	160	80	2190	--	--	3205	--	7885	95	3.0
			Venturi Outlet	3.75	1430	825	130	165	285	2585	--	--	3290	--	8710	110	-0.3
			Spray Tower Inlet	5.45	1220	460	65	85	510	1960	--	--	1815	--	6115	95	3.9
			Spray Tower Outlet	5.30	1310	460	65	89	705	2060	--	--	1825	--	6515	105	3.5
902-1A	86	98	Venturi Inlet	4.45	1285	1395	170	195	55	3385	--	--	3020	2045	11,550	100	11.6
			Venturi Outlet	3.65	1325	1385	175	200	365	3850	--	--	3060	~2045	12,405	120	10.1
			Spray Tower Inlet	5.25	1480	875	100	95	1220	2710	--	--	1620	1445	9545	110	10.8
			Spray Tower Outlet	5.10	1515	855	95	95	1335	2685	--	--	1595	~1445	9620	110	11.1
902-1B	88	99	Venturi Tower Inlet	4.00	1700	1365	175	170	45	2350r	--	--	4600	2355	12,760	90	10.9
			Venturi Tower Outlet	3.15	1680	1350	175	175	295	2705	--	--	4745	~2355	13,480	100	6.7
			Spray Tower Inlet	5.05	1910	845	100	100	1070	2390	--	--	2565	1615	10,595	115	9.8
			Spray Tower Outlet	5.00	1900	875	100	95	1190	2195	--	--	2590	~1615	10,560	105	12.0
903-1A[(a)]	83	98	Venturi Inlet	4.70	2490	1470	190	200	65	2255	--	--	5335	3510	15,515	100	10.9
			Venturi Outlet	4.40	2625	1450	190	200	760	2790	--	--	5445	~3510	16,970	130	7.4
904-1A[(a)]	80	98	Venturi Inlet	4.75	2495	1370	190	210	60	2180	--	--	5170	3690	15,365	100	9.7
			Venturi Outlet	4.40	2650	1385	200	205	605	2395	--	--	5280	3855	16,575	115	10.9
905-1A	85	99	Venturi Inlet	4.55	2965	1665	225	260	60	2180	--	--	7085	2315	16,755	100	12.3
			Venturi Outlet	4.20	3115	1675	245	270	600	2600	--	--	7225	2320	18,050	125	10.8
			Spray Tower Inlet	4.75	2790	1055	130	140	1925	2350	--	--	4390	1410	14,190	130	9.8
			Spray Tower Outlet	--	2780	1040	135	145	1925	2355	--	--	4360	1410	14,150	130	15.0
906-1A	84	99	Venturi Inlet	4.50	3300	1730	255	270	70	2290	--	--	8735	2495	19,145	110	3.1
			Venturi Outlet	4.15	3635	1745	255	275	835	2445	--	--	8900	2495	20,585	125	5.3
			Spray Tower Inlet	5.15	2380	970	135	145	700	1980	--	--	4420	1485	12,215	100	6.9
			Spray Tower Outlet	--	2335	935	130	140	785	1895	--	--	4370	1485	12,075	100	5.4
907-1A	87	98.5	Venturi Inlet	4.65	3145	1070	205	170	65	1870	--	--	6560	2360	15,445	110	4.8
			Venturi Outlet	4.25	3270	1065	210	170	600	1970	--	--	6665	2355	16,305	115	5.7
			Spray Tower Inlet	5.45	2330	640	115	90	405	1800	--	--	3610	1560	10,550	105	6.2
			Spray Tower Outlet	5.30	2355	630	110	90	455	1870	--	--	3600	1560	10,670	110	5.7
907-1B	85	98	Venturi Inlet	4.65	2960	1275	210	190	95	2035	--	--	6420	2155	15,340	105	8.6
			Venturi Outlet	4.15	3110	1265	210	195	680	2230	--	--	6445	2155	16,290	125	9.9
			Spray Tower Inlet	5.35	2440	855	120	110	540	2045	--	--	4070	1510	11,690	110	7.9
			Spray Tower Outlet	5.20	2355	765	115	100	640	2030	--	--	3745	1505	11,255	115	7.7

(a)Venturi - only operation

Table G-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR VENTURI/SPRAY TOWER AND SPRAY TOWER-ONLY TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
908-1A	86	97	Venturi Inlet	4.70	3880	2005	250	245	130	2170	--	--	9320	2220	20,220	110	11.8
			Venturi Outlet	4.30	4135	1960	235	245	740	2250	--	--	9445	2220	21,230	120	12.4
			Spray Tower Inlet	5.30	2995	1325	145	150	620	2050	--	--	5775	1495	14,555	105	13.0
			Spray Tower Outlet	--	2980	1265	145	150	665	2140	--	--	5770	1485	14,600	115	11.6
909-1A[(a)]	85	95	Scrubber Inlet	5.30	1250	580	55	70	755	2410	--	--	895	1480	7495	105	9.3
			Venturi Outlet	4.70	1450	570	50	65	1365	2420	--	--	920	1480	8320	120	13.5
			Spray Tower Outlet	--	1245	570	50	70	775	2370	--	--	900	1480	7460	100	8.2
			Oxidation Tank	5.60	1045	585	55	85	70	2290	--	--	930	1340	6400	90	12.5
910-1A[(a)]	75	71	Scrubber Inlet	5.25	1220	830	65	100	605	2775	--	--	1200	1500	8295	100	12.4
			Venturi Inlet	4.70	1485	825	65	100	1490	2960	--	--	1215	1500	9640	125	13.0
			Spray Tower Outlet	--	1205	795	65	100	560	2745	--	--	1175	1500	8140	100	10.9
			Oxidation Tank	6.95	1060	810	70	105	95	2625	--	--	1215	1400	7380	85	12.1
911-1A[(a)]	84	99	Scrubber Inlet	5.30	1425	970	85	125	560	2705	--	--	1945	1580	9395	100	12.2
			Venturi Inlet	4.90	1650	980	85	125	1315	2870	--	--	1950	1580	10,555	120	12.4
			Spray Tower Outlet	--	1460	960	85	125	525	2760	--	--	1930	1580	9425	105	12.3
			Oxidation Tank	5.60	1345	1000	90	120	40	2645	--	--	1975	1790	9365	95	14.3
912-1A[(a)]	63	40	Scrubber Inlet	5.35	1235	1030	85	140	435	3015	--	--	1820	1580	9340	100	9.8
			Venturi Outlet	4.90	1540	1025	85	135	1370	3180	--	--	1865	1580	10,780	125	9.5
			Spray Tower Outlet	--	1205	1020	90	130	460	2940	--	--	1830	1580	9255	95	8.3
			Oxidation Tank	6.95	1300	1060	90	130	125	3005	--	--	1910	1745	9365	95	10.2
913-1A[(a)]	79	95	Scrubber Inlet	5.10	1495	1110	40	60	870	2910	--	--	2130	1630	10,245	105	10.3
			Venturi Outlet	5.00	1780	1145	70	60	1465	2625	--	--	2130	1630	10,905	105	18.2
			Spray Tower Outlet	--	1475	1105	40	60	925	2890	--	--	2175	1630	10,300	100	6.7
			Oxidation Tank	5.50	1325	1140	65	65	125	2855	--	--	2220	1430	9225	95	13.8
914-1A	79	98.7	V/ST Inlet	4.55	4365	805	130	115	1250	2010	--	--	6725	3990	19,390	143	3.5
			V/ST Outlet	4.45	4450	795	130	115	1650	2095	--	--	6745	3990	19,970	151	3.3
914-1C	64	32	V/ST Inlet	4.60	5200	790	150	120	930	1550	--	--	8800	4000	21,500	118	2.0
			V/ST Outlet	4.45	5500	800	150	110	1180	1580	--	--	8900	4100	22,300	123	4.0

(a) Bleed stream oxidation runs

Table G-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR VENTURI/SPRAY TOWER AND SPRAY TOWER-ONLY TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ioinic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
915-1A[a]	69	26	V/ST Inlet	5.05	4200	770	120	120	390	1650	--	--	6600	3800	17,700	115	4
			V/ST Outlet	4.65	4200	780	120	120	530	1880	--	--	6600	3900	18,100	132	4
		68	Oxidation Tank	5.40	4100	770	130	125	110	1460	--	--	6600	3800	17,000	100	4
915-1B[a]	79	25	V/ST Inlet	5.10	3900	800	110	120	380	1640	--	--	6100	3900	16,900	109	3
			V/ST Outlet	4.80	3700	800	110	120	460	1610	--	--	6000	3800	16,600	106	3
		73	Oxidation Tank	5.70	3900	840	130	120	100	1510	--	--	6100	3900	16,600	98	5
915-1C[a]	76	51	V/ST Inlet	4.80	4600	980	140	140	850	1510	--	--	7600	4000	19,900	104	7
			V/ST Outlet	4.60	4500	980	140	140	900	1640	--	--	7500	4200	20,100	113	6
		97	Oxidation Tank	4.80	4400	950	140	130	160	1470	--	--	7200	4300	18,700	99	8
916-1A	79	99.7	V/ST Inlet	4.65	4000	680	130	100	340	1690	--	--	5900	4100	16,900	121	7
			V/ST Outlet	4.45	4200	700	140	100	1150	1770	--	--	6100	3900	18,100	129	7
			Oxidation Tank	4.70	4400	780	140	110	670	1880	--	--	6600	3900	18,600	135	6
916-1B	76	99.8	V/ST Inlet	4.85	4000	820	160	130	70	1480	--	--	7300	3900	17,800	100	0
			V/ST Outlet	4.60	4200	840	150	130	370	1750	--	--	7100	3900	18,400	121	4
			Oxidation Tank	4.90	4200	870	160	140	45	1700	--	--	7200	3900	18,200	115	3
916-1C	34	99.7	V/ST Inlet	4.85	3380	740	135	110	135	1580	3	32	5670	2375	14.160	105	7.9
			V/ST Outlet	4.50	3485	745	135	110	585	1735	--	--	5640	2375	14,845	118	9.3
			Oxidation Tank	4.65	3400	740	130	105	245	1745	--	--	5630	2360	14,390	117	8.1
916-1D	84	99.8	V/ST Inlet	5.10	3370	720	160	125	80	1550	2	37	5880	1490	13,414	105	8.8
			V/ST Outlet	4.80	3450	700	150	115	480	1700	--	--	5830	1490	13.954	117	7.4
			Oxidation Tank	5.05	3445	725	155	125	150	1760	--	--	5910	1475	13,784	119	7.9
916-1E	88	99.5	V/ST Inlet	5.15	3650	845	170	140	65	1665	2	46	7025	1510	15,108	110	4.3
			V/ST Outlet	4.85	3565	815	165	135	210	1840	--	--	6880	1510	15,168	122	1.8
			Oxidation Tank	5.10	3675	850	175	150	65	1765	--	--	7060	1525	15,313	118	5.4
916-1F	84	99.4	V/ST Inlet	5.15	4200	975	185	175	585	2110	6	48	7405	1510	17,199	142	7.4
			V/St Outlet	4.80	4330	960	185	145	1215	2085	--	--	7395	1510	17,879	143	7.2
			Oxidation Tank	5.05	4270	960	185	145	820	2120	--	--	7430	1495	17,479	144	6.8

(a) Bleed stream oxidation runs

Table G-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR VENTURI/SPRAY TOWER AND SPRAY TOWER-ONLY TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
916-1G	85	99.6	V/ST Inlet	5.35	3900	1020	210	170	35	1785	1	57	7450	1540	16,168	115	8.6
			V/ST Outlet	5.00	4080	1020	195	165	540	1990	--	--	7430	1540	17,018	131	7.9
			Oxidation Tank	5.25	3945	1025	200	160	100	1975	--	--	7470	1515	16,488	128	7.6
916-1H	59	50.4	V/ST Inlet	5.05	3595	1080	185	180	315	1960	6	28	6785	1480	15,614	120	9.7
			V/ST Outlet	4.75	3620	1075	180	290	595	2115	--	--	6930	1480	16,219	131	7.0
			Oxidation Tank	4.75	3685	1100	190	185	680	2015	--	--	6940	1410	16,239	125	9.2
917-1A	86	99.8	ST Inlet	5.07	1005	1570	205	140	36	3985	0.10	35	2015	1530	12,600(a)	92	6.7
			ST Outlet	4.70	1140	1605	210	145	440	4155	2.50	41	2090	1550	13,500(b)	104	7.3
			Oxidation Tank	4.90	1105	1655	210	155	58	4175	--	--	2200	1600	13,400(c)	100	7.7
926-1A	69	49	V/ST Inlet	4.60	3070	1300	110	150	1540	2510	--	--	5340	4090	18,110	130	3.9
			V/ST Outlet	4.30	3280	1300	110	150	1550	2340	--	--	5480	4070	18,280	129	11.4
926-1B	69	49.1	V/ST Inlet	4.85	3010	1240	110	130	965	2360	--	--	5745	1435	14,995	127	8.1
			V/ST Outlet	4.55	3140	1230	110	125	1545	2410	--	--	5735	1435	15,730	134	8.3
926-1C	66	44.5	V/ST Inlet	5.05	2995	1260	120	135	325	2420	--	--	6420	1290	14,785	129	6.2
			V/ST Outlet	4.65	3095	1235	115	135	695	2630	--	--	6135	1290	15,330	144	6.1
926-1D	60	17.4	V/ST Inlet	5.50	3250	1255	115	135	135	2010	--	--	6800	1330	15,030	112	7.7
			V/ST Outlet	5.00	3220	1240	115	130	185	2065	--	--	6795	1330	15,080	115	7.0
926-1E	60	32.1	V/ST Inlet	5.05	2750	945	95	100	325	1950	--	--	5410	735	12,310	113	7.1
			V/ST Outlet	4.60	2850	945	95	95	710	2140	--	--	5380	735	12,950	126	6.6
926-1G	70	50.7	V/ST Inlet	4.85	2815	1375	110	145	875	2365	--	--	5565	2270	15,520	116	7.8
			V/ST Outlet	4.50	2975	1320	110	150	1440	2295	--	--	5570	2270	16,130	120	9.3

(a) Total includes 2115 ppm other S as $SO_4^=$.
(b) Total includes 2210 ppm other S as $SO_4^=$.
(c) Total includes 2235 ppm other S as $SO_4^=$.

Table G-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR VENTURI/SPRAY TOWER AND SPRAY TOWER-ONLY TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/l) ppm											Calculated Percent Gypsum Saturation @ 50^oC	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
926-1H	61	29.9	V/ST Inlet	5.25	3325	1215	115	130	180	2060	--	--	6570	1285	14,880	118	10.1
			V/ST Outlet	4.85	3305	1185	110	130	305	2230	--	--	6515	1285	15,065	129	8.5
927-1M	78	99.4	Venturi Inlet	5.00	3820	790	125	125	75	1505	--	--	5510	4120	16,070	101	11.1
			Venturi Outlet	4.60	3970	760	130	125	1300	1640	--	--	5485	4120	17,530	115	9.9
927-1N	79	99.3	Venturi Inlet	5.10	3710	765	125	110	70	1425	--	--	5680	3720	15,605	95	8.4
			Venturi Outlet	4.70	3810	730	125	110	770	1670	--	--	5680	3720	16,615	115	6.7
927-1O	78	99.2	Venturi Inlet	4.55	4390	790	165	130	30	1470	--	--	7630	4125	18,730	106	4.4
			Venturi Outlet	4.25	4480	800	160	125	460	1785	--	--	7620	4135	19,565	130	5.9
927-1P[(a)]	63	24	Venturi Inlet	5.05	4500	770	150	120	360	1700	--	--	7000	3900	18,500	122	5.0
			Venturi Outlet	4.70	4600	760	150	140	570	1820	--	--	7100	3900	19,000	133	6.0
951-1A	86	95	Venturi Inlet	5.55	1425	300	70	105	130	1420	--	--	1160	--	4000	90	6.0
			Venturi Outlet	4.50	1665	290	75	100	650	1580	--	--	1140	--	4870	105	6.8
			Spray Tower Inlet	7.90	1060	160	40	50	110	1515	--	--	2180	--	5725	95	6.5
			Spray Tower Outlet	5.10	1255	165	40	50	640	1715	--	--	2160	--	6655	115	7.1
952-1A	85	97	Venturi Inlet	5.50	1330	1030	125	150	115	2125	--	--	1560	1380	7360	85	14.0
			Venturi Outlet	4.35	1360	1020	130	160	1160	2165	--	--	1555	~1380	7595	85	13.0
			Spray Tower Inlet	7.75	1260	695	90	105	145	2585	--	--	2295	1585	9215	90	11.8
			Spray Tower Outlet	5.80	1270	700	90	105	330	2745	--	--	2325	~1585	10,485	105	9.4

(a) Venturi-only operation

APPENDIX H

TEST RESULTS SUMMARY TABLES
FOR THE TCA SYSTEM

F

Table H-1

SUMMARY OF TCA LIME RELIABILITY TEST WITH ONE TANK AND WITHOUT FORCED OXIDATION

Run Number	925-2A	
Start-of-Run Date	11/10/78	
End-of-Run Date	1/25/79	
On Stream Hours	1652	
Fly Ash Loading	High	
Gas Rate, acfm @ 300°F	17,000 - 30,000	
Gas Velocity, fps @ 125°F	7.1 - 12.5	
Liquor Rate, gpm	1450	
L/G, gal/Mcf	60 - 106	
Percent Solids Recirculated	7.0 - 9.2	
Effluent Residence Time, min	3.4	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.07 - 1.23	
Avg. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	87	
Inlet O_2 Concentration, vol. %	4.3 - 7.7	
Inlet SO_2 Concentration, ppm	1500 - 3200	
Percent SO_2 Removal	82 - 98	
Avg. SO_2 Make-Per-Pass, m-mole/l	4 - 12	
Scrubber Inlet pH Range	7.5 - 8.5	
Scrubber Outlet pH Range	4.7 - 5.6	
Percent Sulfite Oxidized	6 - 26	
Solids Disposal System	Clarifier/Clarifier & Centrifuge	
Solids in Sludge Discharged, %	28-42/52-63	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	
Total Dissolved Solids, ppm	4500 - 7600	
Total ΔP Range Excluding Mist Elimination System, in. H_2O	5.6 - 13.7	
Mist Elimination System ΔP Range, in. H_2O	0.11 - 0.57	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.).	
Absorbent	Lime Slaked to a 20 wt% slurry with makeup water and added to the internal downcomer. On 11/27/78 addition point moved from internal downcomer to EHT.	
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 932-2A. Actual total bed height was 14 inches at the beginning of the run.	
System Changes Before Start of Run	Switched from limestone/adipic acid to lime after boiler outage. Cleaned I.D. fan damper. Installed new variable speed agitator in D-204 tank.	
Method of Control	Scrubber inlet pH controlled at 8.0±0.2. Recirculated slurry solids controlled at 8±1%. Hold tank (D-204) with internal downcomer was used.	
Run Philosophy	The objective was to operate free from scaling or plugging and to compare conventional lime scrubbing to advanced limestone scrubbing using chemical additives and forced oxidation (V/ST Run 907-1B). Emphasis was placed on assessing the continuous SO_2 emissions monitoring procedures.	
Results	SO_2 removal averaged 90% at 2350 ppm average inlet SO_2 concentration. The mist eliminator was entirely clean of scaling and plugging.	

Table H-2

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING ONE OR TWO TANKS

Run Number	911-2A				
	(1)	(2)	(3)	(4)	(5)
Start-of-Run Date	4/6/79	4/10/79	4/11/79	4/12/79	4/14/79
End-of-Run Date	4/10/79	4/11/79	4/12/79	4/14/79	4/15/79
On Stream Hours	91	23	28	45	21
Fly Ash Loading			High	High	High
Gas Rate, acfm @ 300°F			30,000		
Gas Velocity, fps @ 125°F			12.5		
Liquor Rate, gpm			1200		
L/G, gal/Mcf			50		
Oxidation Tank Residence Time, min.			4.1		
Oxidation Tank Level, ft.			17		
Air Flow Rate to Oxidizer, scfm	220	0	220	350	220
Percent Solids Recirculated	13.5 - 15.7	13.6 - 13.8	14.2 - 15.0	13.0 - 14.2	15.0 - 15.4
Adipic Acid Concentration, ppm	1315 - 1745	1335 - 1630	1070 - 1720	1475 - 1515	1285 - 1495
Scrubber Inlet Liquor Sulfite Concentration, ppm	1510	320	810	85	825
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	2.16 - 3.12	1.11 - 1.28	1.42 - 2.20	1.12 - 1.16	2.30 - 2.56
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	38	84	55	88	41
Inlet O_2 Concentration, vol. %	4.8 - 5.2	4.8 - 6.7	5.2 - 5.8	5.6 - 5.7	5.5 - 5.8
Inlet SO_2 Concentration, ppm	2460 - 2640	2600 - 2660	2280 - 2520	2420 - 2640	2200 - 2600
Percent SO_2 Removal	90 - 97	94 - 97	92 - 97	97 - 98	96 - 98
Avg. SO_2 Make-Per-Pass, mmole/l	12.6	13.1	12.1	13.2	12.6
Scrubber Inlet pH Range	4.7 - 5.3	5.2 - 5.4	5.0 - 5.4	5.2 - 5.4	5.2 - 5.6
Scrubber Outlet pH Range	4.7 - 5.0	4.7 - 4.8	4.8 - 4.9	4.6 - 4.9	4.9 - 5.0
Percent Sulfite Oxidized	96.5 - 98.5	15 - 20	94 - 98	99.0 - 99.5	97 - 98
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.90	0	2.00	2.90	1.95
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	135	125	130	110	130
Total Dissolved Solids, ppm	10,895 - 12,375	9665 - 10,800	9005 - 11,205	9085 - 9505	10,005 - 10,515
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.9 - 11.7	8.2 - 9.2	9.0 - 10.2	8.5 - 10.2	8.6 - 9.7
Mist Elimination System ΔP Range, in. H_2O	0.53 - 0.62	0.54 - 0.60	0.56 - 0.63	0.55 - 0.60	0.55 - 0.61
Solids in Sludge Discharged, %	73 - 82	50 - 71	77 - 79	71 - 76	78
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Mist Elimination System Configuration			Three-pass, open-vane, 316L SS chevron mist eliminator.		
Mist Eliminator Washing Scheme			Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.		

Table H-2 (continued)

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING ONE OR TWO TANKS

Run Number	901-2A				
	(1)	(2)	(3)	(4)	(5)
Oxidizer Design			A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.		
Absorbent			Limestone slurried to 60 wt% and added to the oxidation tank (D-204). Adipic acid dry fed to the oxidation tank.		
Scrubber Internals			Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter of new solid nitrile foam spheres. (Batch No. 1199)		
System Changes Before Start of Run	Switched from lime to limestone. Installed new (Batch No. 1199) 1-7/8 inch diameter nitrile foam spheres with 5 inches in each bed for a total of 15 inches. No cleaning.	Shut air to oxidizer off.	Air rate to oxidizer turned on at 220 scfm, the same as in part (1) of this run.	Air rate to oxidizer increased from 220 to 350 scfm.	Air rate to oxidizer reduced from 350 to 220 scfm.
Method of Control	Limestone stoichiometric ratio held at 1.2 (pH underride of 4.9). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.
Run Philosophy		The original intention of these runs was to determine the effect of agitation and air rate on the degree of sulfite oxidation. In attempting this run the unexplained problem of low limestone utilization, low pH, and high liquor sulfite concentration occurred. Because of this problem, the initial run was never completed and Runs 901-2B through G were never attempted. Instead a series of exploratory runs were made to better define the conditions under which this problem occurred.			
Results	SO_2 removal averaged 93% with 2250 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 97.5%. The centrifuge cake solids content averaged 77%. The adipic acid concentration averaged 1530 ppm in the scrubber inlet liquor. High liquor $SO_3^=$ was measured at 1510 ppm.	SO_2 removal averaged 96% with 2630 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 17%. The centrifuge cake solids content averaged 60%. The adipic acid concentration averaged 1480 ppm in the scrubber inlet liquor. $SO_3^=$ was lowered to near a normal level of 320 ppm.	SO_2 removal averaged 95% with 2400 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 96%. The centrifuge cake solids content averaged 78%. The adipic acid concentration averaged 1395 ppm in the scrubber inlet liquor. $SO_3^=$ increased again to 810 ppm.	SO_2 removal averaged 98% with 2530 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99%. The centrifuge cake solids content averaged 73%. The adipic acid concentration averaged 1495 ppm in the scrubber inlet liquor. $SO_3^=$ was oxidized leaving only 85 ppm in solution.	SO_2 removal averaged 97% with 2400 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 97.5%. The centrifuge cake solids content averaged 78%. The adipic acid concentration averaged 1390 ppm in the scrubber inlet liquor. $SO_3^=$ again rose to 825 ppm.

Table H-2 (continued)

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING ONE OR TWO TANKS

Run Number	901-2H	901-2I	901-2J	
			(1)	(2)
Start-of-Run Date	4/15/79	4/19/79	4/24/79	4/27/79
End-of-Run Date	4/19/79	4/23/79	4/27/79	4/28/79
On Stream Hours	94	92	63	33
Fly Ash Loading	High	High	High	
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	
Liquor Rate, gpm	1200	1200	1200	
L/G, gal/Mcf	50	50	50	
Oxidation Tank Residence Time, min.	4.1	4.1	4.1	
Oxidation Tank Level, ft.	17	17	17	
Air Flow Rate to Oxidizer, scfm	220	220	0	190
Percent Solids Recirculated	14.3 - 16.1	13.6 - 16.4	12.8 - 15.0	13.4 - 16.5
Adipic Acid Concentration, ppm	1325 - 1830	1175 - 1890	1200 - 1845	1400 - 1575
Avg. Scrubber Inlet Liquor Sulfite Concentration, ppm	220	330	325	1055
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.15 - 1.91	1.41 - 2.85	1.06 - 1.24	1.91 - 2.58
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	65	47	86	45
Inlet O_2 Concentration, vol. %	4.8 - 7.4	4.5 - 5.7	4.2 - 5.0	6.1 - 6.5
Inlet SO_2 Concentration, ppm	1950 - 2600	1950 - 2650	2100 - 2800	2350 - 2625
Percent SO_2 Removal	96 - 98.5	96 - 98	88 - 97	90 - 96
Avg. SO_2 Make-Per-Pass, mmole/l	11.5	11.8	12.0	11.9
Scrubber Inlet pH Range	5.0 - 5.6	5.1 - 5.5	5.2 - 5.5	5.0 - 5.2
Srubber Outlet pH Range	4.6 - 5.1	4.7 - 5.2	4.8 - 5.1	4.8 - 5.0
Percent Sulfite Oxidized	98.5 - 99.5	97.5 - 99.5	15 - 33	90 - 98
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.05	2.00	0	1.70
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	120	120	120
Total Dissolved Solids, ppm	8305 - 11,025	9560 - 11,000	8155 - 11,345	11,445 - 11,630
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.2 - 9.4	7.9 - 9.8	8.4 - 10.0	8.6 - 9.3
Mist Elimination System ΔP Range, in. H_2O	0.51 - 0.60	0.52 - 0.60	0.50 - 0.68	0.51 - 0.55
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	
Solids in Sludge Discharged, %	74 - 80	75 - 81	52 - 73	72 - 77
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq. ft.).	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq. ft.).	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (at 0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) through 4 nozzles at 0.4 gpm/sq. ft.).	

Table H-2 (continued)

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING ONE OR TWO TANKS

Run Number	901-2H	901-2I	901-2J	
			(1)	(2)
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316 L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	
Absorbent	Limestone slurried to 60 wt% and added to the suction of the recirculation pump (G-201). Adipic acid dry fed to the oxidation tank (D-204).	Limestone slurried to 60 wt% and added to the suction of the recirculation pump (G-201). Adipic acid dry fed to the process water hold tank (D-203).	Limestone slurried to 60 wt% and added to the oxidation tank (D-204). Adipic acid dry fed to the oxidation tank.	
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 901-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 902-2H.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 902-2I.	
System Changes Before Start of Run	Changed limestone addition point from the oxidation tank (D-204) to the suctions of the recirculation pump (G-201). No other changes. No cleaning. (No shutdown.)	Changed adipic acid addition point from the oxidation tank (D-204) to the process water hold tank (D-203). No other changes. No cleaning.	Changed limestone and adipic acid addition points back to the oxidation tank. Gas duct tie-in to Unit 9 (for future tests). No cleaning.	
Method of Control	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio held at 1.2 (pH underride of 5.2). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.	Air stoichiometric ratio held at 1.7. Limestone pH held at 5.2. Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with internal downcomer was used.
Run Philosophy	In an attempt to better define those conditions causing the problem of low pH, low limestone utilization, and high liquor sulfite concentrations, the limestone addition point was moved to the suction side of the recirculation pump (G-201).	The adipic acid addition point was moved to process water hold tank (D-203) to further explore those conditions which have caused the problem encountered during this test block.	Run conditions and the system configuration were changed back to the original ones to produce samples for chemical laboratory analyses of the slurry liquor.	Due to the loss of the air compressor during the first part of this run, good samples were not obtained. During this portion air stoichiometry was controlled at 1.7.
Results	SO_2 removal averaged 97% with 2275 ppm average inlet SO_2 concentration. Average sulfite oxidation was 99%. The centrifuge cake solids content averaged 77%. The adipic acid concentration averaged 1575 ppm in the scrubber inlet liquor.	SO_2 removal averaged 97% with 2300 ppm average inlet SO_2 concentration. Average sulfite oxidation was 98.5%. The centrifuge cake solids content averaged 78%. The adipic acid concentration averaged 1530 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 93% with 2450 ppm average inlet SO_2 concentration. Average sulfite oxidation was 24%. The centrifuge cake solids content averaged 63%. The adipic acid concentration averaged 1525 ppm in the scrubber inlet liquor.	SO_2 removal averaged 93% with 2500 ppm average inlet SO_2 concentration. Average sulfite oxidation was 94%. The centrifuge cake solids content averaged 75%. The adipic acid concentration averaged 1485 ppm in the scrubber inlet liquor.

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Table H-2 (continued)

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING ONE OR TWO TANKS

Run Number	902-2A	902-2B	903-2A	903-2B
Start-of-Run Date	4/28/79	4/30/79	5/2/79	5/9/79
End-of-Run Date	4/30/79	5/2/79	5/4/79	5/13/79
On Stream Hours	51	39	51	88
Fly Ash Loading	High	High	High	High
Gas Rate, acfm @ 300°F	22,500	22,500	30,000	30,000
Gas Velocity, fps @ 125°F	9.4	9.4	12.5	12.5
Liquor Rate, gpm	900	900	1200	1200
L/G, gal/Mcf	50	50	50	50
Effluent Hold Tk Residence Time, min.	-	-	12.0	12.0
Oxidation Tank Residence Time, min.	5.4	5.4	4.3	4.3
Oxidation Tank Level, ft.	17	17	18	18
Percent Solids Recirculated	13.4 - 16.2	14.1 - 14.2	13.4 - 15.4	14.4 - 16.0
Adipic Acid Concentration, ppm	1375 - 1730	1345 - 1555	1245 - 1860	110 - 1945
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.12 - 2.85	1.38 - 2.23	1.03 - 1.20	1.13 - 1.19
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	50	56	90	86
Inlet O_2 Concentration, vol. %	5.0 - 5.8	4.5 - 5.1	3.7 - 5.1	4.5 - 5.7
Inlet SO_2 Concentration, ppm	2000 - 2510	2430 - 2720	2350 - 3000	2010 - 2720
Percent SO_2 Removal	90 - 94	86 - 91	92 - 96	95
Avg. SO_2 Make-Per-Pass, mmole/l	11.2	11.8	13.2	9.7
Scrubber Inlet pH Range	5.0 - 5.4	5.0 - 5.3	5.1 - 5.5	5.2 - 5.6
Scrubber Outlet pH Range	4.7 - 5.0	4.7 - 4.9	4.3 - 5.0	4.7 - 5.0
Avg. Liquor Sulfite Concentration, ppm	675	1145	55	70
Percent Sulfite Oxidized	97.6 - 99.6	96.8 - 98.4	98.9 - 99.3	99.4 - 99.6
Avg. Air Flow Rate to Oxidizer, scfm	130	160	220	220
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.7	1.9	1.8	2.0
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Belt Filter
Solids in Sludge Discharged, %	77 - 78	74 - 79	76 - 80	86 - 91
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	130	135	95	100
Total Dissolved Solids, ppm	10,410 - 11,860	10,900 - 13,070	8510 - 10,080	8090 - 10,320
Total ΔP Range Excluding Mist Elimination System, in. H_2O	4.8 - 5.4	4.7 - 5.5	7.5 - 8.5	7.5 - 8.5
Mist Elimination System ΔP Range, in. H_2O	0.28 - 0.35	-	-	0.24 - 0.35
Mist Elimination System Configuration	3-Pass, Open-Vane, 316L SS Chevron Mist Eliminator	3-Pass, Open-Vane, 316L SS Chevron Mist Eliminator	3-Pass, Open-Vane, 316L SS Chevron Mist Eliminator	New 3-Pass, Open-Vane 316L SS Chevron Mist Eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.3 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.

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Table H-2 (continued)

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING ONE OR TWO TANKS

Run Number	902-2A	902-2B	903-2A	903-2B
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Agitator speed 54 RPM.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Agitator speed 54 RPM.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 18 ft. Agitator speed 54 RPM.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 18 ft. Agitator speed 54 RPM.
Absorbent	Limestone slurried to 60 wt % with makeup water and added to oxidation tank. Adipic acid dry fed to oxidation tank.	Limestone slurried to 60 wt % with makeup water and added to oxidation tank. Adipic acid dry fed to oxidation tank.	Limestone slurried to 60 wt % with makeup water and added to the EHT. Adipic acid dry fed to oxidation tank.	Limestone slurried to 60 wt % with makeup water and added to the EHT. Adipic acid dry fed to oxidation tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 901-2J.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 902-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 902-2B.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 903-2A.
System Changes Before Start of Run	(No Shutdown)	(No Shutdown)	Changed to two-tank mode. Liquor from the TCA goes directly to the oxidation tank. Liquor from the oxidation tank is fed by gravity to the EHT thru the external downcomer.	Moved raw service water line and changed to Unit 9 flue gas. Installed new 3-Pass 316 SS Chevron Mist Eliminator. Switched clarifier underflow to horizontal vacuum belt filter.
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed with 5.0 TCA inlet slurry pH underride. Recirculated slurry solids controlled at 15± 1%. Adipic acid concentration controlled at 1500 ppm. Air stoich. ratio controlled at 1.7 atoms O/mole SO_2. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed with 5.0 TCA inlet slurry pH underride. Recirculated slurry solids controlled at 15± 1%. Adipic acid concentration controlled at 1500 ppm. Air stoich. ratio controlled at 1.9 atoms O/mole SO_2. Oxidation tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with external downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15± 1%. Adipic acid concentration controlled at 1500 ppm. Oxidation tank (D-204) with external downcomer was used.
Run Philosophy	The purpose of this run was to see if the longer oxidation tank residence time of 5.4 min. would be sufficient to oxidize the unknown sulfite species encountered in previous limestone/adipic acid/oxidation runs (cf. Runs 901-2A, 901-2H, 901-2I, 901-2J).	The purpose of this run was to observe the effect of higher air stoichiometric ratio on liquor sulfite concentration.	The purpose of this run was to operate the system in a manner preparatory to limestone/adipic acid factorial tests. Good oxidation and low liquor sulfite concentration was hoped for.	This run was a continuation of Run 903-2A except using flue gas from Unit 9. Unit 10 was down for servicing.
Results	SO_2 removal averaged 92% at 2255 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.6%. The centrifuge cake solids content averaged 78%. The adipic acid concentration averaged 1550 ppm in the scrubber inlet liquor. The liquor sulfite concentration averaged 675 ppm.	SO_2 removal averaged 88.5% at 2575 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 97.5%. The centrifuge cake solids content averaged 76%. The adipic acid concentration averaged 1450 ppm in the scrubber inlet liquor. The liquor sulfite concentration averaged 1145 ppm.	SO_2 removal averaged 94% at 2675 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99%. The centrifuge cake solids content averaged 78%. The adipic acid concentration averaged 1550 ppm in the scrubber inlet liquor. The liquor sulfite concentration averaged 55 ppm.	SO_2 removal averaged 96% at 2365 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.5%. The centrifuge cake solids content averaged 88%. The adipic acid concentration averaged 1530 ppm in the scrubber inlet licquor. The liquor sulfite concentration averaged 70 ppm.

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Table H-3

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK

- EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2A	904-2B	904-2C	904-2D
Start-of-Run Date	6/26/79	6/30/79	7/6/79	7/15/79
End-of-Run	6/30/79	7/6/79	7/15/79	7/19/79
On Stream Hours	97	124	144	94
Fly Ash Loading	High	High	High	High
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	14.0 - 15.8	14.6 - 15.6	13.7 - 15.2	14.8 - 15.6
Oxidation Tank Residence Time, min.	4.1	4.1	4.1	4.1
Oxidation Tank Level, ft.	17	17	17	17
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.09 - 1.31	1.18 - 1.32	1.12 - 1.26	1.75 - 2.80
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	84	80	84	44
Inlet O_2 Concentration, vol. %	5.7 - 8.2	5.8 - 8.5	6.2 - 7.9	4.0 - 9.0
Inlet SO_2 Concentration, ppm	2150 - 2560	2000 - 2330	2040 - 2400	1950 - 2680
Percent SO_2 Removal	76 - 86	74 - 87	71 - 83	59 - 73
Avg. SO_2 Make-Per-Pass, mmole/l	9.5 - 10.7	8.8 - 9.6	8.8 - 9.6	7.8 - 8.8
Scrubber Inlet pH Range	5.4 - 5.6	5.3 - 5.5	5.2 - 5.4	4.9 - 5.4
Scrubber Outlet pH Range	4.9 - 5.3	5.1 - 5.2	4.9 - 5.1	4.9 - 5.0
Percent Sulfite Oxidized	96.8 - 99.2	98.2 - 100.0	99.1 - 99.7	95.1 - 99.8
Air Flow Rate to Oxidizer, scfm	220	130	220	130
Oxidation Tank Agitator Speed, RPM	54	54	36	36
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.35	1.50	2.65	1.75
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter	Clarifier & Filter
Solids in Sludge Discharged, %	79 - 89	70 - 89	85 - 89	65 - 84
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50° C	110	110	110	155
Total Dissolved Solids, ppm	3540 - 4460	4880 - 5820	5470 - 6170	8150 - 9130
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.5 - 10.1	8.4 - 9.9	7.7 - 9.8	8.2 - 9.3
Mist Elimination System ΔP Range, in. H O	0.25 - 0.33	0.25 - 0.31	0.26 - 0.39	0.27 - 0.32
Mist Elimination System Configuration	Three-pass, open vane, 316L SS Chevron Mist Eliminator	Three-pass, open vane, 316L SS Chevron Mist Eliminator	Three-pass, open vane, 316L SS Chevron Mist Eliminator	Three-pass, open vane, 316L SS Chevron Mist Eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2A	904-2B	904-2C	904-2D
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run TAA-044.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 904-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 904-2B.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 904-2C.
System Changes Before Start of Run	Changed to single-tank operation. Cleaned solids from crossover line. No other changes	(No shutdown)	TCA put on Unit 10 flue gas. No other changes. No cleaning.	(No shutdown)
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed, with an inlet slurry pH underride of 5.2. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 220 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 130 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 220 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 130 scfm.
Run Philosophy	This run is the first in a series designed to determine the effect of agitation and air rate on the degree of sulfite oxidation. This run was made with an agitator speed of 54 RPM and air rate of 220 scfm.	The purpose of this run was to observe the effect of the lower air rate of 130 scfm on sulfite oxidation. Agitator speed was held at 54 RPM.	For this run, the air rate was returned to 220 scfm and the agitator speed was reduced to 36 RPM to see whether agitation speed affects sulfite oxidation.	The agitator study was continued with the air rate reduced to 130 scfm and the agitator speed held at 36 RPM.
Results	SO_2 removal averaged 81% at 2355 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.0%. Filter cake solids content averaged 85%. Average air stoichiometric ratio was 2.36 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 245 ppm.	SO_2 removal averaged 81% at 2165 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.1%. Filter cake solids content averaged 86%. Average air stoichiometric ratio was 1.52 atoms O/mole SO_2 absorbed. Inlet liquor sulfite concentration averaged 225 ppm.	SO_2 removal averaged 77% at 2220 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.4%. Filter cake solids content averaged 88%. The air stoichiometric ratio averaged 2.63 atoms O/mole SO_2 absorbed. Inlet liquor sulfite concentration averaged 95 ppm.	SO_2 removal fell to an average of 66% at 2315 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 97.4%. Filter cake solids content averaged 81%. The air stoichiometric ratio averaged 1.74 atoms O/mole SO_2 absorbed. Inlet liquor sulfite concentration was high, averaging 1040 ppm.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2E	904-2F	904-2G	904-2H
Start-of-Run Date	7/19/79	7/23/79	7/30/79	8/2/79
End-of-Run Date	7/23/79	7/25/79	8/2/79	8/7/79
On Stream Hours	100	46	71	12.5
Fly Ash Loading	High	High	High	High
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	13.5 - 15.1	13.5 - 15.9	14.4 - 16.2	14.0 - 16.2
Oxidation Tank Residence Time, min.	4.1	4.1	4.1	4.1
Oxidation Tank Level, ft.	17	17	17	17
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.17 - 1.27	1.15 - 1.21	1.11 - 1.18	1.16 - 1.36
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	82	85	87	79
Inlet O_2 Concentration, vol. %	6.0 - 10.0	6.0 - 8.5	5.7 - 7.3	7.0 - 9.9
Inlet SO_2 Concentration, ppm	1680 - 2060	1730 - 2200	1020 - 1440	920 - 1400
Percent SO_2 Removal	78 - 86	77 - 87	74 - 89	73 - 91
Avg. SO_2 Make-Per-Pass, mmole/l	7.7 - 8.5	7.9 - 8.7	5.5	5.2
Scrubber Inlet pH Range	5.1 - 5.4	5.3 - 5.5	5.30 - 5.80	5.15 - 5.65
Scrubber Outlet pH Range	4.8 - 4.9	4.6 - 5.3	4.70 - 5.20	4.90 - 5.40
Percent Sulfite Oxidized	98.2 - 100.0	98.8 - 99.8	98.8 - 100	98.5 - 100.0
Air Flow Rate to Oxidizer, scfm	220	350	350	47
Oxidation Tank Agitator Speed, RPM	18	18	36	36
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.95	4.50	7.2	1.0
Solids Disposal System	Clarifier & Filter	Clarifier & Filter	Clarifier only	Clarifier only
Solids in Sludge Discharged, %	83 - 87	85 - 86	37 - 49	30 - 48
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	100	95	110
Total Dissolved Solids, ppm	7275 - 7600	6625 - 7825	5550 - 6000	5540 - 6600
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.0 - 10.7	8.0 - 9.0	7.9 - 9.0	7.9 - 8.9
Mist Elimination System ΔP Range, in. H_2O	0.24 - 0.35	0.26 - 0.33	0.26 - 0.32	0.28 - 0.33
Mist Elimination System Configuration	Three-pass, open vane 316L SS Chevron Mist Eliminator	Three-pass, open vane 316L SS Chevron Mist Eliminator	Three-pass, open vane, 316L SS Chevron Mist Eliminator	Three-pass, open vane 316L SS Chevron Mist Eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. at 0.55 gpm/sq. ft. with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. at 0.55 gpm/sq. ft. with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2E	904-2F	904-2G	904-2H
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 904-2D.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 904-2E.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 904-2F	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 904-2G
System Changes Before Start of Run	(No shutdown)	(No shutdown)	(No shutdown)	(No shutdown)
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 220 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 350 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Oxidizer air rate controlled at 350 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Air stoichiometric ratio controlled at 1.0 atoms O/mole SO_2 absorbed.
Run Philosophy	This run was a continuation of the agitator study. The air rate was increased to 220 scfm and the agitator speed was decreased to 18 RPM.	The agitator study continued with the agitator speed held at 18 RPM and the air rate increased to 350 scfm for this run.	The agitator study continued, with the oxidizer agitator speed held at 36 RPM and the air flow rate set at 350 scfm.	For this run, the oxidizer air rate was varied to maintain an air stoichiometric ratio of 1.0 atoms O/mole SO_2 absorbed, to observe the effect on sulfite oxidation. The agitator speed was 36 RPM.
Results	SO_2 removal averaged 82% at 1870 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99%. Filter cake solids content averaged 86%. Average air stoichiometric ratio was 2.93 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 20 ppm.	SO_2 removal averaged 82% at 1965 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99%. Filter cake solids content averaged 86%. Average air stoichiometric ratio was 4.48 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 10 ppm.	SO_2 removal averaged 83% at 1230 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.4%. Average air stoichiometric ratio was 7.2 atoms O/mole SO_2 absorbed. Inlet liquor sulfite concentration averaged 25 ppm.	SO_2 removal averaged 82% at 1160 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.2%. Average air stoichiometric ratio was controlled at 1.0 atoms O/mole SO_2 absorbed. Inlet liquor sulfite concentration averaged 235 ppm.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2I
Start-of-Run Date	8/7/79
End-of-Run Date	8/9/79
On Stream Hours	40
Fly Ash Loading	High
Gas Rate, acfm @ 300°F	30,000
Gas Velocity, fps @ 125°F	12.5
Liquor Rate, gpm	1200
L/G, gal/Mcf	50
Percent Solids Recirculated	14.6
Oxidation Tank Residence Time, min.	4.1
Oxidation Tank Level, ft.	17
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.18 - 1.23
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	83
Inlet O_2 Concentration, vol. %	6.8 - 7.3
Inlet SO_2 Concentration, ppm	880 - 1440
Percent SO_2 Removal	76 - 90
Avg. SO_2 Make-Per-Pass, mmole/l	4.5
Scrubber Inlet pH Range	5.20 - 5.40
Scrubber Outlet pH Range	4.80 - 5.15
Percent Sulfite Oxidized	98.6 - 99.4
Air Flow Rate to Oxidizer, scfm	47
Oxidation Tank Agitator Speed, RPM	54
Avg. Air Stoichiometric Ratio, 1 lb-atoms oxygen/lb-mole SO_2 absorbed	1.0
Solids Disposal System	Clarifier Only
Solids in Sludge Discharged, %	32 - 36
Calculated Ave. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	90
Total Dissolved Solids, ppm	5355 - 5805
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.2 - 8.9
Mist Elimination System ΔP Range, in. H_2O	0.29 - 0.32
Mist Elimination System Configuration	Three-pass, open vane, 316L SS Chevron Mist Eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.

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Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2I	
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.	
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the oxidation tank.	
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 904-2H	
System Changes Before Start of Run	(No shutdown)	
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids concentration controlled at 15 ± 1%. Air stoichiometric ratio controlled at 1.0 atoms O/mole SO_2 absorbed.	
Run Philosophy	The lower air stoichiometric ratio of 1.0 was further investigated, this time with the agitator speed set at 54 RPM.	
Results	SO_2 removal averaged 84% at 1160 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.0%. Average air stoichiometric ratio was controlled at 1.0 atoms O/mole SO_2 absorbed. Inlet liquor sulfite concentration averaged 20 ppm.	

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Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	904-2J	904-2K	904-2L	904-2M	904-2N	904-2O	904-2P	904-2Q	904-2R	904-2S	904-2T	904-2U
Start-of-Run Date	9-4-79	9-6-79	9-7-79	9-8-79	9-8-79	9-10-79	9-11-79	9-12-79	9-13-79	9-15-79	9-16-79	9-17-79
End-of-Run Date	9-6-79	9-7-79	9-8-79	9-8-79	9-10-79	9-11-79	9-12-79	9-13-79	9-15-79	9-16-79	9-17-79	9-18-79
On Stream Hours	33	24	24	14	38	26	24	29	16	44	24	24
Inlet SO_2 Concentration, ppm	1700-2000	1560-1680	1830-2300	1880-2170	2130-2320	1960-2230	1880-2120	2350-2600	2180-2400	1820-2000	1610-1920	2080-2160
Percent SO_2 Removal	76-84	82-87	72-85	69-83	77-80	70-78	66-84	74-78	80-83	82-85	78-85	83-90
Avg. Make-Per-Pass, mmole/l	7.7-8.1	7.1-7.4	8.1-9.1	7.7-8.5	8.7-9.8	7.8-8.6	6.8-9.0	9.6-10.2	9.5-10.3	8.2-8.8	7.2-8.1	9.95
Percent Solids Recirculated	14.3-15.6	14.9	13.8	15.9	13.0-15.2	14.8	13.2	14.6-15.5	15.0	14.8-16.4	14.4-14.9	12.3
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	2.20-2.32	1.11-1.39	2.76	2.78	1.50-1.85	1.68	1.47	1.54-1.68	1.56	1.31-1.53	1.30-1.45	4.17
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	44	81	36	36	60	60	68	62	64	71	73	24
Scrubber Inlet pH Range	5.0-5.4	5.2-5.6	4.8-5.3	4.9-5.3	5.2-5.3	4.9-5.1	5.0-5.5	5.1-5.4	5.4-5.5	5.3-5.4	5.3-5.4	5.4-5.9
Scrubber Outlet pH Range	4.8-4.95	4.9-5.1	4.8-5.1	4.8	5.1	4.7	4.9	5.0-5.15	5.1	5.3	5.3	5.3
Inlet O_2 Concentration, vol., %	4.5-5.3	5.3-5.7	6.8	6.3	5.2-6.3	6.5	7.0	5.0-5.3	7.0	6.5-7.5	6.4-6.9	6.0
Percent Sulfite Oxidized	97.5-98.5	99.5-100	98.5	99.2	97.8-98.3	98.1	76	72-78	75	98.7-99.4	98.1-98.7	70
Air Flow Rate to Oxidizer, scfm	109	134	139	165	231	188	178	274	247	138	175	245
Oxidation Tank Agitator Speed, RPM	54	54	54	36	36	36	18	18	18	54	36	18
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.50	2.00	1.75	2.20	2.70	2.50	2.45	3.00	2.75	1.75	2.50	2.75
Solids in Sludge Discharged, %	83	81-84	81-82	79	80	86	--	70-72	70	85-98	78-85	--
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	130	95	125	125	130	105	120	110	115	110	110	105
Total Dissolved Solids, ppm	10,550-10,950	9130-9490	9850	10,700	7540-8740	10,350	8280	7700-9050	7950	9300-10,000	9000-9800	8800
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.5-9.4	8.9-9.0	8.7-8.8	8.3-8.9	8.3-9.2	8.8-9.2	8.4-9.3	9.1-9.6	8.7-10.0	8.4-9.3	8.5-9.0	8.9-9.2
Mist Elimination System ΔP Range, in. H_2O	0.28-0.30	0.29-0.31	0.27-0.29	0.26-0.30	0.25-0.30	0.29-0.32	0.28-0.32	0.25-0.30	0.25-0.30	0.25-0.30	0.24-0.30	0.29-0.30

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Fly Ash Loading	High
Gas Rate, acfm @ 300°F	30,000
Gas Velocity, fps @ 125°F	12.5
Liquor Rate, gpm	1200
L/G, gal/Mcf	50
Oxidation Tank Residence Time, min.	4.1
Oxidation Tank Level, ft.	17
Solids Disposal System	Clarifier & Filter
Mist Elimination System Configuration	Three pass, open vane, 316L SS Chevron Mist Eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. at 0.55 gpm/sq. ft. with 7 min. off between nozzles. Bottom washed continuously with diluted clarified water (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.
Absorbent	Limestone slurried to 60 wt. % with makeup water and added to the oxidation tank.
Scrubber Internals	Three beds (four grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run TAA-309. The same spheres were used for all runs.
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used for Runs 904-2J through 904-2R. Changed to external downcomer for Runs 904-2S through 904-2U.
Method of Control	For all runs, the limestone stoichiometric ratio was controlled at 1.2 with a pH underride of 5.2. The recirculated slurry solids concentration was controlled at 15 ± 1%. The air stoichiometric ratio was controlled as shown above.
Run Philosophy	These runs were designed to study the effect air stoichiometry and agitator speed have on sulfite oxidation. They were used to supplement Runs 904-2A through 904-2I and to better define those conditions which cause low pH, low limestone utilization and high liquor sulfite concentrations.
Results:	
Run 904-2J	SO_2 removal averaged 80% at 1860 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.0%. Filter cake solids content averaged 83%. Average air stoichiometric ratio was 1.5 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 720 ppm.
Run 904-2K	SO_2 removal averaged 85% at 1620 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.7%. Filter cake solids content averaged 86%. Average air stoichiometric ratio was 2.0 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 7 ppm.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK

-EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run 904-2L	SO_2 removal averaged 79% at 2065 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.5%. Filter cake solids content averaged 80%. Average air stoichiometric ratio was 1.75 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 175 ppm.
Run 904-2M	SO_2 removal averaged 76% at 2025 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.2%. Filter cake solids content averaged 85%. Average air stoichiometric ratio was 2.2 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 670 ppm.
Run 904-2N	SO_2 removal averaged 79% at 2225 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.0%. Filter cake solids content averaged 82%. Average air stoichiometric ratio was 2.7 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 365 ppm.
Run 904-2O	SO_2 removal averaged 74% at 2095 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.1%. Filter cake solids content averaged 86%. Average air stoichiometric ratio was 2.5 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 470 ppm.
Run 904-2P	SO_2 removal averaged 75% at 2000 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 76%. Average air stoichiometric ratio was 2.45 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 160 ppm.
Run 904-2Q	SO_2 removal averaged 76% at 2475 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 75%. Filter cake solids content averaged 71%. Average air stoichiometric ratio was 3.0 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 250 ppm.
Run 904-2R	SO_2 removal averaged 82% at 2290 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 75%. Filter cake solids content averaged 70%. Average air stoichiometric ratio was 2.75 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 285 ppm.
Run 904-2S	SO_2 removal averaged 84% at 1910 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.0%. Filter cake solids content averaged 87%. Average air stoichiometric ratio was 1.75 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 120 ppm.
Run 904-2T	SO_2 removal averaged 82% at 1765 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98.4%. Filter cake solids content averaged 82%. Average air stoichiometric ratio was 2.5 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 100 ppm.
Run 904-2U	SO_2 removal averaged 86% at 2120 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 70%. Average air stoichiometric ratio was 2.75 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 225 ppm.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run Number	905-2A	905-2B	905-2C	905-2D	905-2E	905-2F	905-2G	905-2H	905-2I
Start-of-Run Date	9-18-79	9-19-79	9-20-79	9-21-79	9-22-79	9-23-79	9-24-79	9-25-79	9-26-79
End-of-Run Date	9-19-79	9-20-79	9-21-79	9-22-79	9-23-79	9-24-79	9-25-79	9-26-79	9-27-79
On Stream Hours	20	20	24	24	24	23	24	24	24
Inlet SO_2 Concentration, ppm	2325-2480	2450-2600	2400-2620	2200-2360	2220-2280	2120-2330	2160-2210	2180-2400	2160-2490
Percent SO_2 Removal	66-80	72-75	73-79	71-75	68-81	75-80	75-80	75-80	76-80
Avg. Make-Per-Pass, mmole/l	8.4-10.3	9.6-10.0	9.5-10.7	8.7-9.0	7.9-8.9	8.9-9.4	8.8-9.2	8.7-9.8	9.0-10.2
Percent Solids Recirculated	15.3-15.4	15.7-15.9	14.6-16.8	13.9-14.7	14.4-15.6	14.6	15.6-16.4	14.9-15.3	15.4
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.17-1.21	1.22-1.27	1.21-1.35	1.19-1.31	1.23-1.66	1.14	1.16-1.27	1.20-1.24	1.25
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	84	80	78	80	69	88	82	82	80
Scrubber Inlet pH Range	5.2-5.6	5.1-5.4	5.2-5.5	5.2-5.4	5.0-5.5	5.3-5.6	5.4-5.7	5.2-5.6	5.3-5.7
Scrubber Outlet pH Range	4.9-5.2	4.7-4.8	4.9-5.0	5.0	4.95-5.0	5.0	5.0-5.1	5.1-5.2	5.1
Inlet O_2 Concentration, vol., %	5.2-6.0	5.5	4.5-5.9	5.5-5.8	5.9-6.0	6.2	6.0	4.8-4.9	5.0
Percent Sulfite Oxidized	31-40	48-62	57-61	48-76	84-87	71	64-74	65	70
Air Flow Rate to Oxidizer, scfm	0	62	79	102	137	138	151	174	202
Oxidation Tank Agitator Speed, RPM	54	54	54	54	54	36	36	36	36
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	0	0.70	0.85	1.25	1.70	1.65	1.80	2.05	2.30
Solids in Sludge Discharged, %	57-61	64	63-64	69-87	69-79	64-73	66-69	69-72	66-70
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	130	115	120	130	115	115	110	110	105
Total Dissolved Solids, ppm	9900-10,500	9900-10,850	8370-8810	8600-8800	8220-8870	7740-8120	7900-8000	7050-7300	7700
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.7-9.4	8.9-9.2	9.0-9.6	8.7-9.3	8.3-9.2	8.6-9.1	8.9-9.6	8.9-9.4	9.0-9.6
Mist Elimination System ΔP Range, in. H_2O	0.27-0.30	0.27-0.31	0.27-0.32	0.25-0.29	0.25-0.30	0.25-0.30	0.25-0.30	0.26-0.34	0.26-0.32

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Fly Ash Loading	High
Gas Rate, acfm @ 300°F	30,000
Gas Velocity, fps @ 125°F	12.5
Liquor Rate, gpm	1200
L/G, gal/Mcf	50
Oxidation Tank Residence Time, min.	4.1
Oxidation Tank Level, ft.	17
Solids Disposal System	Clarifier & Filter
Mist Elimination System Configuration	Three pass, open vane, 316L SS Chevron Mist Eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. at 0.55 gpm/sq. ft. with 7 min. off between nozzles. Bottom washed continuously with diluted clarified water (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.
Absorbent	Limestone slurried to 60 wt. % with makeup water and added to the oxidation tank.
Scrubber Internals	Three beds (four grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 904-2U. The same spheres were used for all runs.
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft. Oxidation tank (D-204) with internal downcomer was used.
Method of Control	For all runs, the limestone stoichiometric ratio was controlled at 1.2 with a pH underride of 5.2. The recirculated slurry solids concentration was controlled at 15 ± 1%. The air stoichiometric ratio was controlled as shown above.
Run Philosophy	These runs were designed as a supplement of the agitator study to further investigate the effects of agitator speed and air stoichiometry on sulfite oxidation. High agitator speeds (36 and 54 RPM) and low air stoichiometries were explored.
Results:	
Run 905-2A	SO_2 removal averaged 73% at 2040 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 35.0%. Filter cake solids content averaged 59%. Average air stoichiometric ratio was 0 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 35 ppm.

Table H-3 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH FORCED OXIDATION USING ONE TANK -EFFECT OF AIR STOICHIOMETRY AND AGITATOR SPEED-

Run 905-2B	SO_2 removal averaged 73% at 2545 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 55%. Filter cake solids content averaged 64%. Average air stoichiometric ratio was 0.70 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 230 ppm.
Run 905-2C	SO_2 removal averaged 76% at 2510 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 59%. Filter cake solids content averaged 64%. Average air stoichiometric ratio was 0.85 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 220 ppm.
Run 905-2D	SO_2 removal averaged 73% at 2280 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 62%. Filter cake solids content averaged 78%. Average air stoichiometric ratio was 1.25 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 72 ppm.
Run 905-2E	SO_2 removal averaged 75% at 2250 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 85%. Filter cake solids content averaged 74%. Average air stoichiometric ratio was 1.7 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 600 ppm.
Run 905-2F	SO_2 removal averaged 77% at 2225 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 67%. Filter cake solids content averaged 68%. Average air stoichiometric ratio was 1.65 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 190 ppm.
Run 905-2G	SO_2 removal averaged 78% at 2185 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 69%. Filter cake solids content averaged 67%. Average air stoichiometric ratio was 1.8 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 240 ppm.
Run 905-2H	SO_2 removal averaged 78% at 2240 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 66%. Filter cake solids content averaged 70%. Average air stoichiometric ratio was 2.05 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 150 ppm.
Run 905-2I	SO_2 removal averaged 78% at 2325 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 65%. Filter cake solids content averaged 68%. Average air stoichiometric ratio was 2.3 atoms O/mole SO_2 absorbed. The inlet liquor sulfite concentration averaged 170 ppm.

Table H-4

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING TWO TANKS

Run Number	906-2A	906-2B	906-2C	906-2D
Start-of-Run Date	10-11-79	10-17-79	10-18-79	10-19-79
End-of-Run Date	10-17-79	10-18-79	10-19-79	10-21-79
On Stream Hours	158	24	24	48
Fly Ash Loading	High	High	High	High
Adipic Acid Concentration, ppm	2115→830	745-800	810-890	860→600
Gas Rate, acfm @ 300°F	25,000	25,000	25,000	25,000
Gas Velocity, fps @ 125°F	10.4	10.4	10.4	10.4
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	60	60	60	60
Percent Solids Recirculated	13.6-16.7	15.0-15.2	14.8-14.9	14.2-15.5
Effluent Hold Tk Residence Time, min.	12	12	12	12
Oxidation Tank Residence Time, min.	4.3	4.3	4.3	4.3
Oxidation Tank Level, ft.	18	18	18	18
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.10-1.30	1.13-1.15	1.27-1.30	1.11-1.22
Avg. % Limestone Utilization, 100x moles SO_2 absorbed/mole Ca added	83	88	78	86
Inlet O_2 Concentration, vol.	5.0-7.4	4.7-6.6	6.0-6.7	6.2-7.2
Inlet SO_2 Concentration, ppm	1520-2400	2220-2400	2160-2280	1760-2240
Percent SO_2 Removal	98.1→94.8	94-96	96-97	96.9→93.6
Avg. SO_2 Make-Per-Pass, mmole/l	8.3	9.7	9.5	8.6
Scrubber Inlet pH Range	5.4-6.0	5.7-6.0	6.0-6.2	5.5-5.9
Scrubber Outlet pH Range	4.8-5.5	5.0-5.1	5.2-5.5	4.8-5.5
Percent Sulfite Oxidized	98.2-100.0	99.1-99.5	99.5-99.6	99.2-100.0
Air Flow Rate to Oxidizer, scfm	185	185	185	185
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.40	2.07	2.12	2.32
Solids Disposal System	Clarifier & Filter	-	Clarifier & Filter	Clarifier & Filter
Solids in Sludge Discharged, %	81-90	15.0-15.2	86-89	83-90
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°F	85	85	95	90
Total Dissolved Solids, ppm	6840-9060	7250-7830	7275-7475	7540-8100
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.7-7.7	7.2-7.6	7.0-7.5	6.8-7.8
Mist Elimination System ΔP Range, in. H_2O	0.17-0.23	0.21-0.25	0.21-0.24	0.20-0.25
Mist Elimination System Configuration	Three-pass, open vane, 316L SS Chevron mist eliminator	Three-pass, open vane, 316L SS Chevron mist eliminator	Three-pass, open vane, 316L SS Chevron mist eliminator	Three-pass, open vane, 316L SS Chevron mist eliminator
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq. ft.) with 7 min. off between nozzles Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq. ft.

Table H-4 (continued)

SUMMARY OF TCA LIMESTONE/ADIPIC ACID TESTS WITH FORCED OXIDATION USING TWO TANKS

Run Number	906-2A	906-2B	906-2C	906-2D
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 18 ft. Oxidation tank (D-204) with external downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 18 ft. Oxidation tank (D-204) with external downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 18 ft. Oxidation tank (D-204) with external downcomer was used.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 18 ft. Oxidation tank (D-204) with external downcomer was used.
Absorbent	Limestone slurried to 60 wt. % with makeup water and added to the EHT. Adipic acid dry fed to the oxidation tank.	Limestone slurried to 60 wt. % with makeup water and added to the EHT. Adipic acid dry fed to the oxidation tank.	Limestone slurried to 60 wt. % with makeup water and added to the EHT. Adipic acid dry fed to the oxidation tank.	Limestone slurried to 60 wt. % with makeup water and added to the EHT. Adipic acid dry fed to the oxidation tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run TAA064.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 906-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 906-2B.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 906-2C.
System Changes Before Start of Run	No changes, no shutdown.	No shutdown. Changed to open loop configuration. (No clarified liquor or filtrate returned to the system).	No shutdown. Changed to closed loop configuration.	No changes, no shutdowns.
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed with an inlet pH underride of 5.2. Recirculated slurry solids controlled at 15 ± 1 %. Air rate to oxidizer controlled at 220 scfm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed with an inlet pH underride of 5.2. Recirculated slurry solids controlled at 15 ± 1 %. Air rate to oxidizer controlled at 220 scfm. Adipic acid concentration controlled at 800 ppm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed with an inlet pH underride of 5.2. Recirculated slurry solids controlled at 15 ± 1 %. Air rate to oxidizer controlled at 220 scfm. Adipic acid concentration controlled at 800 ppm.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed with an inlet pH underride of 5.2. Recirculated slurry solids controlled at 15 ± 1 %. Air rate to oxidizer controlled at 220 scfm.
Run Philosophy	The purpose of these runs was to examine the effect of low adipic acid concentrations on SO_2 removal for both open and closed loop operation. This was a closed loop depletion run starting at 2000 ppm and finishing at 800 ppm adipic acid.	This was run in the open loop mode; i.e., no clarified liquor or filtrate was returned to the system. The adipic acid concentration was controlled at 800 ppm to compare fresh to aged adipic acid.	This run reverted to closed loop operation at 800 ppm adipic acid concentration for comparison with Run 906-2B.	This was a depletion run with initially 800 ppm and ending at 400 ppm adipic acid concentration.
Results	SO_2 removal averaged from 98.1% to 94.8% at 1945 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.2%. Filter cake solids content averaged 86%. The adipic acid concentration dropped from 2115 to 830 ppm in the scrubber inlet liquor.	SO_2 removal averaged 95.3% at 2300 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.3%. The adipic acid concentration averaged 770 ppm in the scrubber inlet liquor.	SO_2 removal averaged 96.5% at 2220 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.6%. Filter cake solids content averaged 88%. The adipic acid concentration averaged 850 ppm in the scrubber inlet liquor.	SO_2 removal averaged from 96.9% to 93.6% at 2050 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 99.6%. Filter cake solids content averaged 87%. The adipic acid concentration dropped from 860 ppm to 600 ppm in the scrubber inlet liquor. The run was terminated prematurely to turn the TCA system over to TVA.

Table H-5

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2A	907-2B	907-2C
Start-of-Run Date	9-16-80	9-22-80	9-25-80
End-of-Run Date	9-22-80	9-25-80	9-30-80
Onstream Hours	221	71	124
Fly Ash Loading	Low	Low	Low
Adipic Acid Concentration, ppm	2290-2650	2490-3120	2375-2690
Gas Rate, acfm @ 300°F	30,000	30,000	30,000
Liquor Rate, gpm	1200	1200	1200
Scrubber L/G, gal/mcf	50	50	50
Percent Solids Recirculated	8.9-11.4	9.8-10.3	9.8-10.5
Effluent Hold Tank Residence Time, min.	35	29	22
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.04-1.17	1.08-1.11	1.91-2.08
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	91	91	50
Inlet O_2 Concentration, vol. %	-	7.2	-
Inlet SO_2 Concentration, ppm	2720-2900	2520-2600	2560-2800
Overall Percent SO_2 Removal	94-97	96-97	90-95
Average SO_2 Make-per-pass, m-mole/l	14.2	13.1	12.9
Scrubber Inlet pH Range	4.65-4.90	4.65-4.95	4.70-4.90
Scrubber Outlet pH	4.30-4.40	4.50-4.55	4.40-4.55
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99.4-100	96.1-99.7	98.7-99.6
Solids Disposal System	Clarifier & Belt Filter	Clarifier & Belt Filter	Clarifier & Belt Filter
Solids in Cake Discharged, %	81-93	89-93	88
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	101	100	111
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	11,800-12,900	13,000-13,400	13,700-13,800
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	8.8-11.6	8.2-9.4	7.1-8.3
Mist Elimination System ΔP Range, in. H_2O	.29-.32	.28-.31	.27-.32
Scrubber Inlet $SO_3^=$ Concentration, ppm	290	180	830
Scrubber Outlet $SO_3^=$ Concentration, ppm	1200	875	1670
Scrubber Liquor Fe Concentration, ppm	-	2	5
Scrubber Liquor Mn Concentration, ppm	-	28	-
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 mi (at .55 gpm/sq.ft.) with 7 min. off between nozzl Bottom washed continuous with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2A	907-2B	907-2C
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2H.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2A.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2B.
System Changes Before Start of Run	Replaced 10,500 of the HDPE spheres (one-third of total).	Replaced all the HDPE spheres.	(No shutdown)
Method of Control	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 18 ft.	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 15 ft.	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 11 ft.
Run Philosophy	This is the first run of the Springfield Simulation series to operate with forced oxidation. The objective is to measure the effect of this on overall system performance.	The objective was to observe the effect of lowering the EHT residence time from 35 to 29 minutes by lowering the EHT level from 18 to 15 ft.	The objective was to observe the effect of lowering the EHT residence time from 29 to 22 minutes by lowering the EHT level from 15 to 11 ft.
Results	SO_2 removal averaged 95.3% at 2835 ppm average inlet SO_2 concentration and 2485 ppm Adipic acid. Filter cake solids content averaged 89%. Sulfite oxidation was 99.8%. Limestone utilization fell from an average of 97.7 for the past 8 runs to 91%.	SO_2 removal averaged 96.5% at 2570 ppm average inlet SO_2 concentration and 2700 ppm Adipic acid. Filter cake solids content averaged 91%. Sulfite oxidation was 98.4%. Limestone utilization was 91%.	SO_2 removal averaged 93.0% at 2620 ppm average inlet SO_2 concentration and 2545 ppm Adipic acid. Filter cake solids content averaged 88% and sulfite oxidation was 99.1%. Limestone utilization was 50%.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2D	907-2E	907-2F
Start-of-Run Date	10-04-80	10-10-80	10-16-80
End-of-Run Date	10-10-80	10-16-80	10-21-80
Onstream Hours	142	144	120
Fly Ash Loading	Low	Low	Low
Adipic Acid Concentration, ppm	2520-2770	2550-2860	2260-2570
Gas Rate, acfm @ 300°F	30,000	25,000	20,000
Liquor Rate, gpm	1200	1200	1200
Scrubber L/G, gal/mcf	50	60	75
Percent Solids Recirculated	9.9-11.0	9.3-10.6	9.6-10.0
Effluent Hold Tank Residence Time, min.	22	22	22
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.27-1.58	1.25-1.34	1.10-1.13
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	66	77	89
Inlet O_2 Concentration, vol. %	-	5.6-6.7	5.9-6.8
Inlet SO_2 Concentration, ppm	2400-2600	2400-2720	2260-2560
Overall Percent SO_2 Removal	95-97	94-95	95-96
Average SO_2 Make-per-pass, m-mole/l	10.6	9.14	7.0
Scrubber Inlet pH	4.42-4.78	4.70-4.83	4.67-4.89
Scrubber Outlet pH	4.36-4.48	4.33-4.42	4.29-4.40
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99.6-100.0	99.4-100.0	99.4-100.0
Solids Disposal System	Clarifier & Belt Filter	Clarifier & Belt Filter	Clarifier & Belt Filter
Solids in Cake Discharged, %	81-91	89-91	84-93
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	100	110
Total Dissolved Solids in Scrubber Inlet Liquor ppm	12,600-13,300	13,200-13,700	13,000-13,900
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	7.3-8.5	5.3-6.1	4.3-4.8
Mist Elimination System ΔP Range, in. H_2O	.29-.34	.22-.26	.14-.19
Scrubber Inlet $SO_3^=$ Concentration, ppm	110	40	120
Scrubber Outlet $SO_3^=$ Concentration, ppm	1000	780	715
Scrubber Liquor Fe Concentration, ppm	-	0.4	0.4
Scrubber Liquor Mn Concentration, ppm	-	46	4.9
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 mi (at .55 gpm/sq.ft.) with 7 min. off between nozzl Bottom washed continuous with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2D	907-2E	907-2F
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2C.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2D.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2E.
System Changes Before Start of Run	System restored from down operating mode.	(no shutdown)	(No shutdown)
Method of Control	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10 ± 1%. Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 11 ft.	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10 ± 1%. Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 11 ft.	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10 ± 1% Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 11 ft.
Run Philosophy	Air to oxidizer was increased from 250 to 350 scfm to increase the oxidation intensity to improve the limestone utilization.	Flue gas rate was lowered from 30,000 to 25,000 acfm to lower the SO_2 make-per-pass which in turn would increase the limestone utilization.	Flue gas rate was lowered from 25,000 to 20,000 acfm to lower the SO_2 make-per-pass which in turn would increase the limestone utilization.
Results	Limestone utilization increased from 50 to 66%. SO_2 removal averaged 96.4% at 2520 ppm average inlet SO_2 concentration and 2675 ppm adipic acid. Sulfite oxidation averaged 99.9%.	SO_2 make-per-pass decreased from 10.6 to 9.14 mmoles/l and limestone utilization increased from 66 to 76.9%. SO_2 removal averaged 93.9% at 2530 ppm average SO_2 inlet concentration and 2710 ppm adipic acid. Sulfite oxidation averaged 99.9%.	SO_2 make-per-pass decreased from 9.14 to 7.0 mmoles/l and limestone utilization increased from 76.9 to 89.3%. SO_2 removal averaged 95.3% at 2450 ppm average SO_2 inlet concentration and 2450 ppm adipic acid. Sulfite oxidation averaged 99.7%.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2G	907-2J	907-2K
Start-of-Run Date	10-21-80	10-27-80	11-03-80
End-of-Run Date	10-26-80	11-03-80	11-07-80
Onstream Hours	136	162	88
Fly Ash Loading	Low	Low	Low
Adipic Acid Concentration, ppm	2430-2770	1690-2260	1920-2490
Gas Rate, acfm @ 300°F	20,000	30,000	30,000
Liquor Rate, gpm	600	1200	1200
Scrubber L/G, gal/mcf	37	50	50
Percent Solids Recirculated	9.9-10.0	5.4-11.1	9.4-10.3
Effluent Hold Tank Residence Time, min.	43	29	35
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.04-1.05	1.10-2.78	1.02-1.05
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	95	81	97
Inlet O_2 Concentration, vol. %	6.8-7.1	6.5-8.7	7.0-7.7
Inlet SO_2 Concentration, ppm	2280-2400	1800-2560	2000-2480
Overall Percent SO_2 Removal	60-76	97-98	97-98
Average SO_2 Make-per-pass, m-mole/l	9.44	11.8	11.8
Scrubber Inlet pH	4.58-5.08	4.88-5.17	4.91-5.08
Scrubber Outlet pH	4.18-4.34	4.48-4.69	4.20-4.50
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99.7-100.0	89.3-100.0	99.7-100.0
Solids Disposal System	Clarifier & Belt Filter	Clarifier & Belt Filter	Clarifier & Belt Filter
Solids in Cake Discharged, %	90-94	90-98	86-94
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	110	120	115
Total Dissolved Solids in Scrubber Inlet Liquor ppm	13,800-14,300	10,800-11,600	10,600-11,300
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	3.1-3.4	7.8-13.5	8.7-11.1
Mist Elimination System ΔP Range, in. H_2O	.12-.16	.20-.32	.25-.31
Scrubber Inlet $SO_3^=$ Concentration, ppm	50	290	70
Scrubber Outlet $SO_3^=$ Concentration, ppm	1260	500	195
Scrubber Liquor Fe Concentration, ppm	0.3	0.5	1.0
Scrubber Liquor Mn Concentration, ppm	11	41	4.2
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 mi (at .55 gpm/sq.ft.) with 7 min. off between nozzl Bottom washed continuous with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2G	907-2J	907-2K
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2F.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2G.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2J.
System Changes Before Start of Run	(No shutdown)	Air sparger on nozzles cleaned.	(No shutdown)
Method of Control	Scrubber inlet pH is controlled at 4.8. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2500 ppm. EHT level maintained at 11 ft.	Scrubber inlet pH is controlled at 5.0. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2000 ppm. EHT level maintained at 15 ft.	Scrubber inlet pH is controlled at 5.0. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2000 ppm. EHT level maintained at 18 ft.
Run Philosophy	The effect of lowering the slurry flow rate from 1200 to 600 gpm, which raised the EHT residence time from 22 to 43 minutes, was investigated.	The object of this run was to observe the effect of raising the pH to 5.0 from 4.8 along with raising the flue gas rate to 30,000 acfm and the slurry rate to 1200 gpm.	The EHT level was raised from 15 to 18 ft. to increase the contact time betweet the oxidizing air and the slurry.
Results	SO_2 removal averaged 70.6% at an average of 2355 ppm inlet SO_2 concentration and 2510 ppm adipic acid. Limestone utilization increased from 89.3 to 95.2%. Sulfite oxidation averaged 99.9%.	SO_2 removal averaged 97.6% at an average of 2355 ppm inlet SO_2 concentration and 2005 ppm adipic acid. Limestone utilization was 81.3% and sulfite oxidation was 99.8%.	Limestone utilization went from 81.3 to 96.6%. SO_2 removal remained high at 97.2% at an SO_2 inlet concentration of 2255 ppm and 2060 ppm adipic acid. Sulfite oxidation was 99.9%.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2L	907-2M
Start-of-Run Date	11-07-80	11-13-80
End-of-Run Date	11-13-80	11-16-80
Onstream Hours	148	84
Fly Ash Loading	Low	Low
Adipic Acid Concentration, ppm	1430-2120	1490-1720
Gas Rate, acfm @ 300°F	30,000	30,000
Liquor Rate, gpm	1200	1200
Scrubber L/G, gal/mcf	50	50
Percent Solids Recirculated	9.5-10.0	9.3-10.3
Effluent Hold Tank Residence Time, min.	35	29
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.05-1.12	1.61-2.48
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	91	48
Inlet O_2 Concentration, vol. %	6.3-7.5	6.6-6.7
Inlet SO_2 Concentration, ppm	2320-2600	2360-2520
Overall Percent SO_2 Removal	97-99	92-98
Average SO_2 Make-per-pass, m-mole/l	12.6	12.3
Scrubber Inlet pH	4.98-5.21	5.15-5.57
Scrubber Outlet pH	3.86-4.58	4.62-4.97
Percent Sulfite Oxidized in Scrubber Inlet Slurry	99.7-100.0	78.1-99.5
Solids Disposal System	Clarifier & Belt Filter	Clarifier & Belt Filter
Solids in Cake Discharged, %	83-92	79-80
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	120	125
Total Dissolved Solids in Scrubber Inlet Liquor ppm	10,900-12,300	12,300-14,200
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	8.7-17.0	8.2-11.3
Mist Elimination System ΔP Range, in. H_2O	.22-.30	.24-.27
Scrubber Inlet $SO_3^=$ Concentration, ppm	185	1530
Scrubber Outlet $SO_3^=$ Concentration, ppm	725	1940
Scrubber Liquor Fe Concentration, ppm	0.5	2.0
Scrubber Liquor Mn Concentration, ppm	46	53
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-5 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND FORCED OXIDATION

Run Number	907-2L	907-2M
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2K.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 907-2L.
System Changes Before Start of Run	(No shutdown)	(No shutdown)
Method of Control	Scrubber inlet pH is controlled at 5.2. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1800 ppm. EHT level maintained at 18 ft.	Scrubber inlet pH is controlled at 5.2. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1800 ppm. EHT level maintained at 15 ft.
Run Philosophy	The effect of raising the pH to 5.2 and decreasing the adipic acid concentration to 1600 ppm was observed.	The object of this run was to observe the effect of lowering the EHT level to 15 ft. at the same conditions as 907-2L.
Results	SO_2 removal was 98.0% and limestone utilization was 90.9%. SO_2 inlet concentration averaged 2450 ppm and adipic acid concentration was 1740 ppm.	Limestone utilization dropped from 90.9 to 47.6%. SO_2 removal was 94.7 at an average inlet SO_2 concentration of 2435 ppm and an adipic acid level of 1590 ppm.

Table H-6

SUMMARY OF TCA LIMESTONE TESTS WITH AND WITHOUT ADIPIC ACID ADDITION

Run Number	926-2A	927-2A	928-2A	929-2A
Start-of-Run Date	7/4/78	8/4/78	8/22/78	9/5/78
End-of-Run Date	7/12/78	8/20/78	9/5/78	9/13/78
On Stream Hours	192	374	252	186
Fly Ash Loading	High	High	High	High
Adipic Acid Addition	No	Yes	Yes	Yes
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	13.7 - 16.4	13.7 - 15.5	13.3 - 16.6	13.6 - 15.4
Effluent Residence Time, min	4.1	4.1	4.1	4.1
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.09 - 1.42	1.04 - 1.34	1.06 - 1.30	1.17 - 1.33
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	80	84	85	80
Inlet O_2 Concentration, vol. %	6.0 - 9.0	5.4 - 8.2	6.0 - 9.0	-
Inlet SO_2 Concentration, ppm	2300 - 3200	1300 - 3300	1800 - 3400	1300 - 3300
Percent SO_2 Removal	62 - 80	54 - 96	89 - 97	87 - 97
Avg. SO_2 Make-Per-Pass, m-mole/l	10.1	9.1	12.8	11.2
Scrubber Inlet pH Range	5.4 - 5.9	4.9 - 5.7	5.2 - 5.6	5.35 - 5.65
Scrubber Outlet pH Range	5.0 - 5.5	4.7 - 5.2	4.8 - 5.1	5.0 - 5.3
Percent Sulfite Oxidized	6 - 20	6 - 32	6 - 22	6 - 14
Solids Disposal System	Clarifier	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	31 - 43	56 - 68	56 - 62	56 - 62
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	90	110	100	110
Total Dissolved Solids, ppm	3400 - 5100	6000 - 9700	8600 - 11,600	7600 - 11,800
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.7 - 8.6	6.5 - 7.4	6.3 - 7.0	6.1 - 7.1
Mist Elimination System ΔP Range, in. H_2O	0.53 - 0.62	0.52 - 0.60	0.48 - 0.63	0.49 - 0.56
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter new nitrile foam spheres (type 1098).	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter new nitrile foam spheres (type 1101).	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 927-2A.	Three-beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 928-2A.
System Changes Before Start of Run	Cleaned mist eliminator after 7621 hours of operation. Switched from lime to limestone. Replaced 1-5/8 inch diameter old nitrile foam spheres with new 1-7/8 inch diameter spheres.	Switched from lime to limestone. Replaced type 1098 nitrile foam spheres with type 1101 new spheres. No cleaning.	No changes. No cleaning.	Cleaned I.D. fan damper. No other changes.
Method of Control	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 300 ppm. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 750 ppm. Hold tank (D-204) with internal downcomer was used.
Run Philosophy	Base case limestone run without adipic acid addition and without forced oxidation. The results will be compared with succeeding limestone/adipic acid runs to observe the effect of adipic acid on SO_2 removal.	The objective was to observe the effect of 300 ppm adipic acid concentration on SO_2 removal (cf. Run 926-2A without adipic acid).	The objective was to observe the effect of increasing the adipic acid concentration from 300 ppm to 1500 ppm on SO_2 removal.	The objective was to observe the effect of 750 ppm adipic acid on SO_2 removal. The results are to be compared to prior runs of this test block (cf. 926-2A without adipic acid, 927-2A, and 928-2A) and future runs.
Results	SO_2 removal averaged 71% with 2750 ppm average inlet SO_2 concentration. The mist eliminator was 1% restricted at the end of the run.	SO_2 removal averaged 75% with 2300 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 350 ppm in the scrubber inlet liquor. The mist eliminator was 3% restricted at the end of the run.	SO_2 removal averaged 93% with 2600 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 1600 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 92% at 2300 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 885 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of this run.

Table H-6 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH AND WITHOUT ADIPIC ACID ADDITION

Run Number	930-2A	931-2A	932-2A	933-2A
Start-of-Run Date	9/13/78	9/20/78	9/26/78	1/25/79
End-of-Run Date	9/20/78	9/26/78	11/2/78	2/8/79
On Stream Hours	162	137	833	328
Fly Ash Loading	High	High	High	High
Adipic Acid Addition	Yes	Yes	Yes	No
Gas Rate, acfm @ 300°F	30,000	30,000	20,000 - 30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	8.4 - 12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50 - 75	50
Percent Solids Recirculated	14.3 - 15.7	13.0 - 14.8	13.7 - 15.9	12.6 - 15.3
Effluent Residence Time, min	4.1	4.1	4.1	4.1
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.21 - 1.47	1.03 - 1.11	1.10 - 1.34	1.10 - 1.31
Avg. % Limestone Utilization, 100x moles SO_2 abs./mole Ca added	75	93	82	Limestone 83
Inlet O_2 Concentration, vol. %	-	-	5.0 - 7.0	5.0 - 7.0
Inlet SO_2 Concentration, ppm	1800 - 3300	1700 - 2900	1400 - 3500	1400 - 2500
Percent SO_2 Removal	87 - 99	64 - 90	94 - 98	65 - 87
Avg. SO_2 Make-Per-Pass, m-mole/l	12.6	9.4	4 - 17	7.9
Scrubber Inlet pH Range	5.3 - 5.9	4.6 - 5.3	5.0 - 5.6	5.2 - 5.7
Scrubber Outlet pH Range	5.0 - 5.4	4.3 - 4.9	4.6 - 5.3	4.9 - 5.3
Percent Sulfite Oxidized	6 - 20	10 - 38	8 - 34	14 - 34
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	54 - 62	56 - 68	57 - 65	53 - 61
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	80	110	110	110
Total Dissolved Solids, ppm	7100 - 11,700	9800 - 12,700	9200 - 16,400	7200 - 10,600
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.2 - 7.1	6.3 - 7.3	5.2 - 9.2	7.8 - 9.1
Mist Elimination System ΔP Range, in. H_2O	0.50 - 0.63	0.52 - 0.59	0.19 - 0.65	0.44 - 0.59
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on for 3 min. (0.55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup water plus necessary clarified liquor) using 2 nozzles at 0.4 gpm/sq.ft.
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT. Adipic acid dry fed to EHT.	Limestone slurried to 60 wt% with makeup water and added to the EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 929-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 930-2A.	Three beds (4 grids) with nominally 5 inches/bed 1-7/8 inch diameter nitrile foam spheres from Run 931-2A plus new spheres. Actual measured total bed height was 14 inches at the end of the run.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 625-2A. Actual total bed height was 13 inches at the end of the run.
System Changes Before Start of Run	No changes. No cleaning.	No changes. No cleaning.	Cleaned I.D. fan damper and reheater ductwork. Removed fallout solids from mist eliminator. Added 5 inches of new spheres (type 1101) to middle bed; used spheres from Run 931-2A were redistributed to top & bottom beds to give 5 inches/bed.	Switched from lime to limestone. Cleaned cross-over line to D-204 tank.
Method of Control	Limestone stoichiometric ratio controlled at 1.35 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 750 ppm. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.05 moles Ca/mole SO_2 absorbed. Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 750 ppm. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed (override: TCA inlet pH not less than 5.1). Recirculated slurry solids controlled at 15 ± 1%. Adipic acid concentration controlled at 1500 ppm. Hold tank (D-204) with internal downcomer was used.	Limestone stoichiometric ratio controlled at 1.2 moles Ca/mole SO_2 absorbed. Recirculated solids controlled at 15 ± 1%. Hold tank (D-204) with internal downcomer was used.
Run Philosophy	The objective was to observe the effect of an increase in limestone stoichiometric ratio from 1.2 to 1.35 on SO_2 removal (cf. Run 929-2A).	The objective was to observe the effect on SO_2 removal of decreasing the limestone stoichiometric ratio to 1.05 (cf. Run 929-2A and 930-2A).	This was a one-month reliability test. The objective was to obtain consistently greater than 90 percent SO_2 removal with adipic acid additive, and to have an operation free of scaling and plugging during one month of testing.	The main objective was to provide a base limestone case without adipic acid for the Bioassay Sampling tests. This run will also serve to verify the results of the base case limestone Run 926-2A (without forced oxidation) conducted in July 1978.
Results	SO_2 removal averaged 93% at 2550 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 700 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of the run, but it was found 5% restricted due to fallout solids from the outlet duct.	SO_2 removal averaged 77% at 2300 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 840 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of the run, but it was found 10% restricted due to fallout solids from the outlet duct.	SO_2 removal averaged 96% at 2450 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 1620 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of the run and fallout solids on the mist eliminator were negligible. The entire scrubber system was free of scaling and plugging.	SO_2 removal averaged 76% at 1950 ppm average inlet SO_2 concentration. Centrifuge cake solids content averaged 57%. The mist eliminator was entirely clean at the end of the run.

Table H-7

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	934-2C	934-2A	934-2B
Start-of-Run Date	7-18-80	7-31-80	8-5-80
End-of-Run Date	7-31-80	8-5-80	8-9-80
Onstream Hours	296	194	85 1/4
Fly Ash Loading	Low	Low	Low
Adipic Acid Concentration, ppm	1460-1540	1490-1630	1430-1550
Gas Rate, acfm @ 300°F	30,000	30,000	30,500
Liquor Rate, gpm	1200	1200	1200
Scrubber L/G, gal/mcf	50	50	50
Percent Solids Recirculated	8.7-11.8	9.2-10.8	9.1-10.1
Effluent Hold Tank Residence Time, min.	37.2	37.2	37.2
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.03-1.07	1.00-1.03	1.02-1.04
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	96.7	98.9	98.5
Inlet O_2 Concentration, vol. %	6.7-7.5	8.0-9.3	9.4-10.0
Inlet SO_2 Concentration, ppm	1920-2280	2120-2560	2160-2620
Overall Percent SO_2 Removal	88-94	49-69	75-85
Average SO_2 Make-per-pass, m-mole/l	10.4	7.3	9.9
Scrubber Inlet pH Range	5.1-5.5	4.3-4.8	4.8-5.1
Scrubber Outlet pH	4.6-4.9	4.8-4.2	4.2-4.4
Percent Sulfite Oxidized in Scrubber Inlet Slurry	30-50	53.0-61.4	38.6-44.2
Solids Disposal System	Clarifier & Belt Filter	Clarifier & Belt Filter	Clarifier & Drum Filter
Solids in Cake Discharged, %	78-79	87-88	70-75
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	100	95	101
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	8250-8640	10,300-11,500	9620-10,2000
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	6.9-8.7	7.0-8.4	7.0-7.6
Mist Elimination System ΔP Range, in. H_2O	.28-.33	.28-.32	.28-.32
Scrubber Inlet $SO_3^=$ Concentration, ppm	492	2690	1200
Scrubber Outlet $SO_3^=$ Concentration, ppm	1136	3340	2140
Scrubber Liquor Fe Concentration, ppm	-	41-69	19
Scrubber Liquor Mn Concentration, ppm	-	50-56	-
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-7 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	934-2C	934-2A	934-2B
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the effluent hold tank.	Limestone slurried to 60 wt% with with makeup water and added to the effluent hold tank. Acipic acid dry fed to the effluent hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Acipic acid dry fed to the effluent hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres with an average weight of 5.76 grams.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2C.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2A.
System Changes Before Start of Run	System restored from Down operating mode.	(no shutdown)	(no shutdown)
Method of Control	Scrubber inlet pH is controlled at 5.4 Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1500 ppm	Scrubber inlet pH is controlled at 4.6 Recirculated slurry solids concentration controlled at 10% ± 1% Adipic acid concentration controlled at 1500 ppm	Scrubber inlet pH is controlled at 5.0 Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1500 ppm
Run Philosophy	This run is the first of a series which will provide information useful to the EPA during their support of the full scale adipic acid demonstration at Springfield City utilities in Springfield, Missouri.	The objective was to observe the effect of scrubber inlet pH of 4.6 on system performance.	The objective was to observe the effect of scrubber inlet pH of 5.0 on system performance.
Results	SO_2 removal averaged 93% at 2100 ppm average inlet SO_2 concentration and 1500 ppm adipic acid. Filter cake solids content averaged 78%. Natural oxidation averaged 42%.	SO_2 removal averaged 59% at 2350 ppm average inlet SO_2 concentration and 1550 ppm adipic acid. Filter cake solids content averaged 85%. Natual oxidation averaged 57%.	SO_2 removal averaged 82% at 2300 ppm average inlet SO_2 concentration and 1480 ppm adipic acid. Filter cake solids content averaged 73%. Natual oxidation averaged 40%.

Table H-7 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	934-2E	934-2F	934-2D
Start-of-Run Date	8-9-80	8-14-80	8-20-80
End-of-Run Date	8-13-80	8-20-80	8-27-80
Onstream Hours	95	136	168
Fly Ash Loading	Low	Low	Low
Adipic Acid Concentration, ppm	1430-1630	1430-1690	1460-1630
Gas Rate, acfm @ 300°F	30,000	30,000	30,000
Liquor Rate, gpm	1200	1200	1200
Scrubber L/G, gal/mcf	50	50	50
Percent Solids Recirculated	9.3-11.5	8.7-10.1	9.7-10.4
Effluent Hold Tank Residence Time, min.	37.2	37.2	37.2
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	.95-1.04	.97-1.01	1.03-1.05
Avg. % Limestone Utilization, 100 x moles SO_2 abs./mole Ca added	98.0	98.2	96.0
Inlet O_2 Concentration, vol. %	8.7-10.0	5.8-6.2	7.2-7.9
Inlet SO_2 Concentration, ppm	2160-2600	2040-2440	2040-2520
Overall Percent SO_2 Removal	72-85	37-53	91-96
Average SO_2 Make-per-pass, m-mole/l	10.1	5.3	11.8
Scrubber Inlet pH Range	4.9-5.1	4.5-4.7	5.3-5.5
Scrubber Outlet pH	4.1-4.3	3.7-4.5	4.5-4.8
Percent Sulfite Oxidized in Scrubber Inlet Slurry	33.7-47.4	47.0-51.9	20.5-26.0
Solids Disposal System	Clarifier & Drum Filter	Clarifier & Belt Filter	Clarifier & Belt Filter
Solids in Cake Discharged, %	66-80	84-88	71-76
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	107	104	103
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	9990-10,700	12,300-13,800	10,700-11,100
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	6.8-7.8	7.1-8.4	8.5-9.5
Mist Elimination System ΔP Range, in. H_2O	.28-.32	.30-.34	.30-.35
Scrubber Inlet $SO_3^=$ Concentration, ppm	1330	3040	643
Scrubber Outlet $SO_3^=$ Concentration, ppm	2430	3870	1560
Scrubber Liquor Fe Concentration, ppm	-	46	3
Scrubber Liquor Mn Concentration, ppm	3	5	2
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzl Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-7 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	934-2E	934-2F	934-2D
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Acipic acid dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Acipic acid dry fed to the limestone feed hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2B	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2E.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2F.
System Changes Before Start of Run	(no shutdown)	Cleaned I.D. Fan.	(no shutdown)
Method of Control	Scrubber inlet pH is controlled at 5.0 Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1500 ppm	Scrubber inlet pH is controlled at 4.6 Recirculated slurry solids concentration controlled at 10% ± 1% Adipic acid concentration controlled at 1500 ppm	Scrubber inlet pH is controlled at 5.4 Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1500 ppm
Run Philosophy	The objective was to observe what effect changing the adipic acid addition point by comparing to Run 934-2B	The objective was to observe what effect changing the adipic acid addition point by comparing to Run 934-2A	The objective was to observe what effect changing the adipic acid addition point by comparing to Run 934-2C
Results	SO_2 removal averaged 78% at 2410 ppm average inlet SO_2 concentration and 1540 ppm adipic acid. Filter cake solids content averaged 71%. Natural oxidation averaged 38%.	SO_2 removal averaged 44% at 2280 ppm average inlet SO_2 concentration and 1530 ppm adipic acid. Filter cake solids content averaged 87%. Natural oxidation averaged 50%.	SO_2 removal averaged 95% at 2340 ppm average inlet SO_2 concentration and 1570 ppm adipic acid. Filter cake solids content averaged 74%. Natual oxidation averaged 23%.

Table H-7 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	934-2G	934-2H
Start-of-Run Date	8-27-80	9-2-80
End-of-Run Date	9-2-80	9-10-80
Onstream Hours	145	192
Fly Ash Loading	Low	Low
Adipic Acid Concentration, ppm	1460-1690	2320-2720
Gas Rate, acfm @ 300°F	30,000	30,000
Liquor Rate, gpm	900	900
Scrubber L/G, gal/mcf	37	37
Percent Solids Recirculated	9.3-9.9	9.7-10.4
Effluent Hold Tank Residence Time, min.	50	50
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.02-1.03	0.99-1.04
Avg. % Limestone Utilization, 100 x Moles SO_2 abs./mole Ca added	98	97
Inlet O_2 Concentration, vol. %	7.2-7.9	-
Inlet SO_2 Concentration, ppm	2160-2400	2120-2200
Overall Percent SO_2 Removal	61-68	74-84
Average SO_2 Make-per-pass, m-mole/l	10.3	11.8
Scrubber Inlet pH Range	4.95-5.20	4.90-5.15
Scrubber Outlet pH	3.90-4.10	4.05-4.30
Percent Sulfite Oxidized in Scrubber Inlet Slurry	26.9-29.5	19.5-33.8
Solids Disposal System	Clarifier & Belt Filter	Clarifier & Belt Filter
Solids in Cake Discharged, %	78-81	76-78
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	98.3	104.0
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	11,800-12,400	13,200-14,300
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	5.8-6.4	6.1-6.7
Mist Elimination System ΔP Range, in. H_2O	.29-.33	.29-.34
Scrubber Inlet $SO_3^=$ Concentration, ppm	1120-1710	1000-1450
Scrubber Outlet $SO_3^=$ Concentration, ppm	2340-2810	2440-3140
Scrubber Liquor Fe Concentration, ppm	-	8
Scrubber Liquor Mn Concentration, ppm	-	3
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.3 gpm/sq.ft.	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min (at .55 gpm/sq.ft.) with 7 min. off between nozzle Bottom washed continuously with diluted clarified liquor (all available makeup liquor) through 2 nozzles at 0.3 gpm/sq.ft.

Table H-7 (continued)

SUMMARY OF TCA LIMESTONE TESTS WITH ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	934-2G	934-2H
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank. Adipic acid dry fed to the limestone feed hold tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2D.	Three beds (4 grids) with nominally 5 inches/bed of 38 mm diameter high density polyethylene spheres from Run 934-2G.
System Changes Before Start of Run	(No shutdown)	(No shutdown)
Method of Control	Scrubber inlet pH is controlled at 5.0. Recirculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 1500 ppm.	Scrubber inlet pH is controlled at 5.1. Reciruculated slurry solids concentration controlled at 10% ± 1%. Adipic acid concentration controlled at 2500 ppm.
Run Philosophy	The objective was to observe the effect of lowering the slurry flow rate from 1200 900 gpm.	The objective was to observe the effect of an adipic acid concentration of 2500 ppm at a slurry flow rate of 900 gpm.
Results	SO_2 removal averaged 64.9% at 2325 ppm average inlet SO_2 concentration and 1575 ppm adipic acid. Filter cake solids content averaged 80%. Natural oxidation averaged 26.9%.	SO_2 removal averaged 78.3% at 2120 ppm average inlet SO_2 concentration and 2475 ppm adipic acid. Filter cake solids content averaged 78%. Natural oxidation averaged 25.1%

Table H-8

SUMMARY OF TCA LIMESTONE RELIABILITY VERIFICATION TEST WITH 1-FT GLITSCH GRID PACKING

Run Number	935-2A
Start-of-Run Date	12/2/80
End-of-Run Date	12/10/80
Onstream Hours	128
Fly Ash Loading	High
Adipic Acid Concentration, ppm	-
Gas Rate, acfm @ 300°F	30,000
Liquor Rate, gpm	1200
Scrubber L/G, gal/mcf	50
Percent Solids Recirculated	14.5-16.8
Effluent Hold Tank Residence Time, min.	12
Limestone Stoichiometric Ratio, moles Ca/mole SO_2 absorbed	1.15-1.30
Avg. % Limestone Utilization, 100 x Moles SO_2 abs./mole Ca added	81
Inlet O_2 Concentration, vol. %	5.0-7.8
Inlet SO_2 Concentration, ppm	2240-2640
Overall Percent SO_2 Removal	61-85
Average SO_2 Make-per-pass, m-mole/l	9.5
Scrubber Inlet pH Range	5.58-5.93
Scrubber Outlet pH	5.04-5.37
Percent Sulfite Oxidized in Scrubber Inlet Slurry	4.8-19.9
Solids Disposal System	Clarifier & Belt Filter
Solids in Cake Discharged, %	52-57
Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	100
Total Dissolved Solids in Scrubber Inlet Liquor, ppm	3320-5620
Total ΔP Range, Excluding Mist Elimination System, in. H_2O	7.8-10.6
Mist Elimination System ΔP Range, in. H_2O	0.2-0.3
Scrubber Inlet $SO_3^=$ Concentration, ppm	187-377
Scrubber Outlet $SO_3^=$ Concentration, ppm	303-606
Scrubber Liquor Fe Concentration, ppm	0.25
Scrubber Liquor Mn Concentration, ppm	1.6
Mist Elimination System Configuration	Three pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on 3 min. (at .55 gpm/sq.ft.) with 7 min. off between nozzles. Bottom washed continuously with diluted clarified liquor (all available makeup liquor(through 2 nozzles at 0.4 gpm/ sq.ft.

Table H-8 (continued)

SUMMARY OF TCA LIMESTONE RELIABILITY VERIFICATION TEST WITH 1-FT GLITSCH GRID PACKING

Run Number	935-2A
Absorbent	Limestone slurried to 60 wt% with makeup water and added to the effluent hold tank.
Scrubber Internals	Four grids and 1 ft. Glitsch Grid packing installed between 2nd and 3rd grids.
System Changes Before Start of Run	No changes
Method of Control	Limestone stoichiometric ratio controlled at 1.2. Recirculated slurry solids controlled at 15 ± 1%. EHT level at 6'2".
Run Philosophy	The objectives of this run were to observe the Glitsch Grid packing SO_2 removal efficiency and to assess the scaling and plugging potential of the packing .
Results	SO_2 removal averaged 72.7% at an average of 2475 ppm inlet SO_2 concentration. One third of the Grid had accumulated crystalline solids.

Table H-9

SUMMARY OF TCA LIME/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	951-2A	951-2B	951-2C	951-2D
Start-of-Run Date	3/15/79	3/20/79	3/24/79	3/28/79
End-of-Run Date	3/20/79	3/24/79	3/28/79	3/31/79
On Stream Hours	57	102	89	64
Fly Ash Loading	High	High	High	High
Adipic Acid Concentration, ppm	1085 - 1345	1030 - 1430	1100 - 1440	1125 - 1395
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	8.5 - 9.1	7.2 - 8.8	7.6 - 8.8	7.4 - 8.2
Oxidation Tank Residence Time, min.	4.1	4.1	4.1	4.1
Oxidation Tank Level, ft.	17	17	17	17
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.05 - 1.11	1.01 - 1.07	1.01 - 1.05	1.01 - 1.03
Avg. % Lime Utilization, 100 x moles SO_2 abs./mole Ca added	93	96	97	98
Inlet O_2 concentration, vol. %	4.5 - 5.0	4.8 - 6.6	4.6 - 6.4	5.1 - 6.6
Inlet SO_2 concentration, ppm	2650 - 2950	2100 - 3000	2300 - 2800	1800 - 2500
Percent SO_2 Removal	96 - 98	93 - 97	90 - 96	80 - 90
Avg. SO_2 Make-Per-Pass, m-mole/l	14.4	12.8	12.5	9.7
Scrubber Inlet pH Range	6.7 - 7.2	5.2 - 5.8	4.8 - 5.2	4.3 - 4.9
Scrubber Outlet pH Range	4.6 - 5.0	4.2 - 4.8	3.5 - 4.1	3.1 - 3.3
Percent Sulfite Oxidized	43 - 51	78 - 98	92 - 98	93 - 99
Air Flow Rate to Sparger, scfm	220	220	220	220
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	1.65	1.85	1.90	2.45
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	59 - 62	72 - 76	72 - 76	69 - 73
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	115	110	110
Total Dissolved Solids, ppm	8665 - 9575	9045 - 9825	9110 - 10,030	8900 - 10,510
Total ΔP Range Excluding Mist Elimination System, in. H_2O	7.6 - 8.4	8.4 - 10.0	9.8 - 12.0	9.0 - 11.1
Mist Elimination System ΔP Range, in. H_2O	0.53 - 0.61	0.55 - 0.65	0.53 - 0.62	0.52 - 0.66
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzles (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)

Table H-9 (continued)

SUMMARY OF TCA LIME/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	951-2A	951-2B	951-2C	951-2D
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to the oxidation tank. Adipic acid dry fed to the oxidation tank.	Lime slaked to a 20 wt% slurry with makeup water and added to the oxidation tank. Adipic acid dry fed to the oxidation tank.	Lime slaked to a 20 wt% slurry with makeup water and added to the oxidation tank. Adipic acid dry fed to the oxidation tank.	Lime slaked to a 20 wt% slurry with makeup water and added to the oxidation tank. Adipic acid dry fed to the oxidation tank.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 981-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 951-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 951-2B.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 951-2C.
System Changes Before Start of Run	Installed 3 inch air pipe in D-204 oxidation tank. Cleaned I.D. fan.	No changes. No cleaning. (No shutdown.)	No changes. No cleaning. (No shutdown.)	No changes. No cleaning. (No shutdown.)
Method of Control	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Oxidation tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 5.5 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Oxidation tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 5.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Oxidation tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 4.5 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Oxidation tank (D-204) with internal downcomer was used.
Run Philosophy	The purpose of this run was to see whether good SO_2 removal and sulfite oxidation could be obtained when oxidation is forced within the scrubber loop of a lime/adipic acid system at a normal lime system pH of 7.0.	The purpose of this run was to try to improve sulfite oxidation by lowering the scrubber inlet pH from 7.0 to 5.5 and see if SO_2 removal is significantly affected by the lowered pH.	The purpose of this run was to further reduce the pH, from 5.5 to 5.0, to further improve sulfite oxidation and observe the effect of lower pH on SO_2 removal	The purpose of this run was to determine the lower limit of pH at which good SO_2 removal can be obtained. The pH was lowered from 5.0 to 4.5.
Results	SO_2 removal averaged 97% with 2800 ppm average inlet SO_2 concentration. Average sulfite oxidation was only 47%. The centrifuge cake solids content averaged 61%. The adipic acid concentration averaged 1215 ppm in the scrubber inlet liquor.	SO_2 removal averaged 95% with 2550 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 88%. The centrifuge cake solids content averaged 74%. The adipic acid concentration averaged 1230 ppm in the scrubber inlet liquor.	SO_2 removal averaged 93% with 2550 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 95%. The centrifuge cake solids content averaged 74%. The adipic acid concentration averaged 1270 ppm in the scrubber inlet liquor.	SO_2 removal averaged 85% with 2150 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 96%. The centrifuge cake solids content averaged 71%. The adipic acid concentration averaged 1260 ppm in the scrubber inlet liquor.

Table H-9 (continued)

SUMMARY OF TCA LIME/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	951-2E	
Start-of-Run Date	3/31/79	
End-of-Run Date	4/6/79	
On Stream Hours	103	
Fly Ash Loading	High	
Adipic Acid Concentration, ppm	1145 - 1515	
Gas Rate, acfm @ 300°F	30,000	
Gas Velocity, fps @ 125°F	12.5	
Liquor Rate, gpm	1200	
L/G, gal/Mcf	50	
Percent Solids Recirculated	7.1 - 8.5	
Oxidation Tank Residence Time, min.	4.1	
Oxidation Tank Level, ft.	17	
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.01 - 1.05	
Avg. % Lime Utilization, 100x moles SO_2 absorbed/mole Ca added	97	
Inlet O_2 Concentration, vol. %	4.5 - 6.3	
Inlet SO_2 Concentration, ppm	2100 - 2700	
Percent SO_2 Removal	75 - 89	
Avg. SO_2 Make-Per-Pass, mmole/l	10.4	
Scrubber Inlet pH Range	4.7 - 5.2	
Scrubber Outlet pH Range	3.3 - 3.9	
Percent Sulfite Oxidized	96.5 - 99.5	
Air Flow Rate to Oxidizer, scfm	220	
Avg. Air Stoichiometric Ratio, lb-atoms oxygen/lb-mole SO_2 absorbed	2.30	
Solids Disposal System	Clarifier & Centrifuge	
Solids in Sludge Discharged, %	70 - 74	
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	105	
Total Dissolved Solids, ppm	8850 - 10,220	
Total ΔP Range Excluding Mist Elimination System, in. H_2O	7.8 - 9.2	
Mist Elimination System ΔP Range, in. H_2O	0.51 - 0.63	
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	

Table H-9 (continued)

SUMMARY OF TCA LIME/ADIPIC ACID TESTS WITH ONE TANK AND FORCED OXIDATION

Run Number	951-2E	
Oxidizer Design	A single 3-inch diameter 316L SS pipe which extends to the center of the oxidation tank and discharges air downward through an open elbow 5 inches from the bottom of the tank. Oxidation tank diameter is 7 ft. Tank slurry level was 17 ft.	
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to the oxidation tank. Adipic acid dry fed to the oxidation tank.	
Scrubber Internals	Three bed (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter solid nitrile foam spheres from Run 951-2D. Actual total bed height was 13 inches at the end of the run.	
System Changes Before Start of Run	No changes. No cleaning. (No shutdown)	
Method of Control	Scrubber inlet pH controlled at 5.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Oxidation tank (D-204) with internal downcomer was used.	
Run Philosophy	The purpose of this run was to reconfirm the data obtained from Run 951-2C.	
Results	SO_2 removal averaged 82% with 2400 ppm average inlet SO_2 concentration. Sulfite oxidation averaged 98%. The centrifuge cake solids content averaged 72%. The adipic acid concentration averaged 1330 ppm in the scrubber inlet liquor. The mist eliminator was entirely clean at the end of the run.	

Table H-10

SUMMARY OF TCA LIME TESTS WITH AND WITHOUT ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	976-2A	976-2B	977-2A	978-2A
Start-of-Run Date	7/12/78	7/19/78	7/25/78	2/8/79
End-of-Run Date	7/19/78	7/25/78	8/4/78	2/13/79
On Stream Hours	160	133	236	116
Fly Ash Loading	High	High	High	High
Adipic Acid Addition, ppm	No	No	Yes	No
Gas Rate, acfm @ 300°F	30,000	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	1200	1200
L/G, gal/Mcf	50	50	50	50
Percent Solids Recirculated	14.2 - 15.6	7.5 - 8.7	7.4 - 8.6	6.8 - 9.4
Effluent Residence Time, min.	4.1	4.1	4.1	4.1
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.06 - 1.13	1.04 - 1.12	1.04 - 1.14	1.06 - 1.13
Avg. % Lime Utilization, 100x moles SO_2 abs./mole Ca added	91	93	92	92
Inlet O_2 Concentration, vol. %	7.0 - 9.0		6.0 - 7.0	4.2 - 5.4
Inlet SO_2 Concentration, ppm	2600 - 3100	2600 - 3300	2000 - 3400	1800 - 2900
Percent SO_2 Removal	66 - 74	62 - 72	71 - 89	77 - 89
Avg. SO_2 Make-Per-Pass, m-mole/l	10.5	10.7	11.6	10.3
Scrubber Inlet pH Range	6.6 - 7.4	6.7 - 7.3	6.7 - 7.2	6.7 - 7.3
Scrubber Outlet pH Range	4.8 - 5.0	4.8 - 5.0	4.6 - 5.1	4.5 - 4.8
Percent Sulfite Oxidized	6 - 26	4 - 20	3 - 17	14 - 28
Solids Disposal System	Clarifier and Centrifuge	Clarifier and Centrifuge	Clarifier and Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	60 - 66	60 - 66	57 - 64	57 - 62
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	90	85	90	125
Total Dissolved Solids, ppm	4600 - 6200	4700 - 5500	5200 - 6100	10030 - 11420
Total ΔP Range Excluding Mist Elimination System, in. H_2O	6.6 - 8.7	6.6 - 7.7	6.4 - 8.0	8.4 - 9.5
Mist Elimination System ΔP Range, in. H_2O	0.53 - 0.65	0.52 - 0.60	0.54 - 0.67	0.43 - 0.53
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to the internal downcomer.	Lime slaked to a 20 wt% slurry with makeup water and added to the internal downcomer.	Lime slaked to a 20 wt% slurry with makeup water and added to the internal downcomer. Adipic acid dry fed to EHT.	Lime slaked to a 20 wt% slurry with makeup water and added to the EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 926-1A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 976-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 976-2B.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 933-2A. Actual total bed height was 14 inches after addition of 1 inch new (1101) spheres to middle bed before the run.
System Changes Before Start of Run	Switched from limestone to lime. No other changes. No cleaning.	Installed new corrosion coupons racks below mist eliminator and in EHT (D-204). No other changes. No cleaning.	No changes. No cleaning.	Changed from limestone to lime. Cleaned I.D. fan damper. Added 1 inch of new 1-7/8 inch diameter nitrile foam spheres to middle bed.
Method of Control	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 15 ± 1%. Holds tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Hold tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 300 ppm. Hold tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Hold tank (D-204) with internal downcomer was used.
Run Philosophy	Base case lime run without adipic acid addition. The results will be compared with succeeding lime/adipic acid runs to observe the effect of adipic acid on SO_2 removal.	Base case lime run without adipic acid addition. The results will be compared with succeeding lime/adipic acid runs to observe the effect of adipic acid on SO_2 removal.	The objective was to observe the effect of 300 ppm adipic acid concentration on SO_2 removal. (cf. Run 976-2B without adipic acid.)	The main objective was to provide a base case using lime with no oxidation and no adipic acid. This run should also verify the results of basa case lime Run 976-2B, run under the same test conditions except for the lime addition point.
Results	SO_2 removal averaged 70% with 2850 ppm average inlet SO_2 concentration. The slurry solids were controlled at 15 wt% by mistake. The mist eliminator was 0.2% restricted at the end of the run.	SO_2 removal averaged 67% with 2950 ppm average inlet SO_2 concentration. The mist eliminator was 1% restricted at the end of the run.	SO_2 removal averaged 80% with 2700 ppm, average inlet SO_2 concentration. The adipic acid concentration averaged 420 ppm in the scrubber inlet liquor. The mist eliminator was 1% restricted at the end of the run.	SO_2 removal averaged 83% with 2350 ppm average inlet SO_2 concentration. The centrifuge cake solids content averaged 60%.

Table H-10 (continued)

SUMMARY OF TCA LIME TESTS WITH AND WITHOUT ADIPIC ACID AND WITHOUT FORCED OXIDATION

Run Number	979-2A	980-2A	981-2A
Start-of-Run Date	2/13/79	2/22/79	3/12/79
End-of-Run Date	2/20/79	3/12/79	3/15/79
On Stream Hours	177	247	70
Fly Ash Loading	High	High	High
Adipic Acid Concentration, ppm	520 - 720	1125 - 1485	1070 - 1400
Gas Rate, acfm @ 300°F	30,000	30,000	30,000
Gas Velocity, fps @ 125°F	12.5	12.5	12.5
Liquor Rate, gpm	1200	1200	900
L/G, gal/Mcf	50	50	37
Percent Solids Recirculated	7.2 - 9.0	7.9 - 8.9	7.8 - 8.6
Effluent Residence Time, min.	4.1	4.1	5.4
Stoichiometric Ratio, moles Ca added/mole SO_2 absorbed	1.04 - 1.14	1.07 - 1.19	1.07 - 1.15
Avg. % Lime Utilization, 100x moles SO_2 abs./mole Ca added	92	88	90
Inlet O_2 Concentration, vol.%	4.2 - 5.0	4.4 - 5.6	4.3 - 5.9
Inlet SO_2 Concentration, ppm	2600 - 3200	2550 - 2950	2300 - 2900
Percent SO_2 Removal	90 - 96	97 - 98	88 - 96
Avg. SO_2 Make-Per-Pass, m-mole/l	14.3	14.3	17.0
Scrubber Inlet pH Range	6.8 - 7.6	6.6 - 7.3	6.7 - 7.2
Scrubber Outlet pH Range	4.4 - 4.7	4.6 - 5.0	4.4 - 4.8
Percent Sulfite Oxidized	11 - 17	5 - 15	7 - 11
Solids Disposal System	Clarifier & Centrifuge	Clarifier & Centrifuge	Clarifier & Centrifuge
Solids in Sludge Discharged, %	52 - 57	53 - 61	59 - 61
Calculated Avg. % Gypsum Saturation in Scrubber Inlet Liquor @ 50°C	90	75	100
Total Dissolved Solids, ppm	8470 - 9240	7730 - 8620	8275 - 10,125
Total ΔP Range Excluding Mist Elimination System, in. H_2O	8.1 - 9.5	7.7 - 8.7	6.7 - 8.0
Mist Elimination System ΔP Range, in. H_2O	0.46 - 0.58	0.48 - 0.62	0.45 - 0.60
Mist Elimination System Configuration	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open-vane, 316L SS chevron mist eliminator.	Three-pass, open vane, 316L SS chevron mist eliminator.
Mist Eliminator Washing Scheme	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)	Top washed sequentially with makeup water. Each nozzle (6 total) on for 4 min. (at 0.55 gpm/sq.ft.) with 76 min. off between nozzles. Bottom washed intermittently with makeup water. The nozzles (2 total) were on for 6 min. every 4 hours (at 1.5 gpm/sq.ft.)
Absorbent	Lime slaked to a 20 wt% slurry with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Lime slaked to a 20 wt% slurry with makeup water and added to the EHT. Adipic acid dry fed to the EHT.	Lime slaked to a 20 wt% slurry with makeup water and added to the EHT. Adipic acid dry fed to the EHT.
Scrubber Internals	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 978-2A.	Three beds (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 979-2A.	Three bed (4 grids) with nominally 5 inches/bed of 1-7/8 inch diameter nitrile foam spheres from Run 980-2A.
System Changes Before Start of Run	(No shutdown)	No changes. No cleaning.	(No shutdown)
Method of Control	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 600 ppm. Hold tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Hold tank (D-204) with internal downcomer was used.	Scrubber inlet pH controlled at 7.0 ± 0.2. Recirculated slurry solids controlled at 8 ± 1%. Adipic acid concentration controlled at 1200 ppm. Hold tank (D-204) with internal downcomer was used.
Run Philosophy	The objective was to observe the effect of 600 ppm adipic acid concentration on SO_2 removal. (cf. Run 978-2A without adipic acid).	The objective was to observe the effect of 1200 ppm adipic acid concentration on SO_2 removal in an unoxidized system. (cf. Run 979-2A with 600 ppm adipic acid).	The objective was to observe the effect of reduced liquor rate (lower L/G) on SO_2 removal. (cf. Run 980-2A).
Results	SO_2 removal averaged 93% with 2900 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 620 ppm. The centrifuge cake solids content averaged 55%. The mist eliminator was entirely clean at the end of the run.	SO_2 removal averaged 97.5% with 2750 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 1305 ppm. The centrifuge cake solids content averaged 57%.	SO_2 removal averaged 92% with 2600 ppm average inlet SO_2 concentration. The adipic acid concentration averaged 1235 ppm. The centrifuge cake solids content averaged 60%. The mist eliminator was entirely clean at the end of the run.

APPENDIX I

GRAPHICAL OPERATING DATA FROM THE TCA TESTS

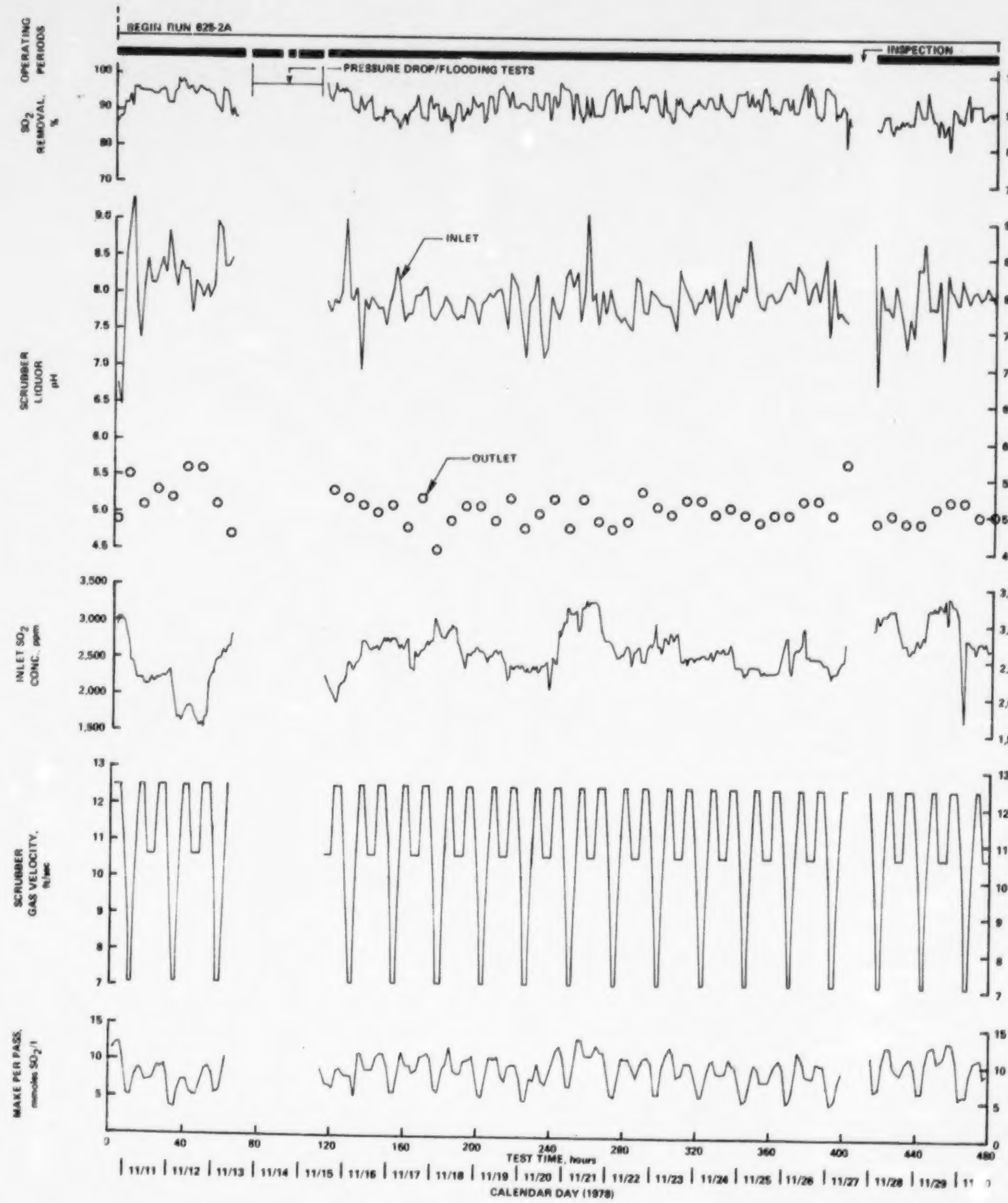


Figure I-1. Operating Data For TCA Run 625-2A

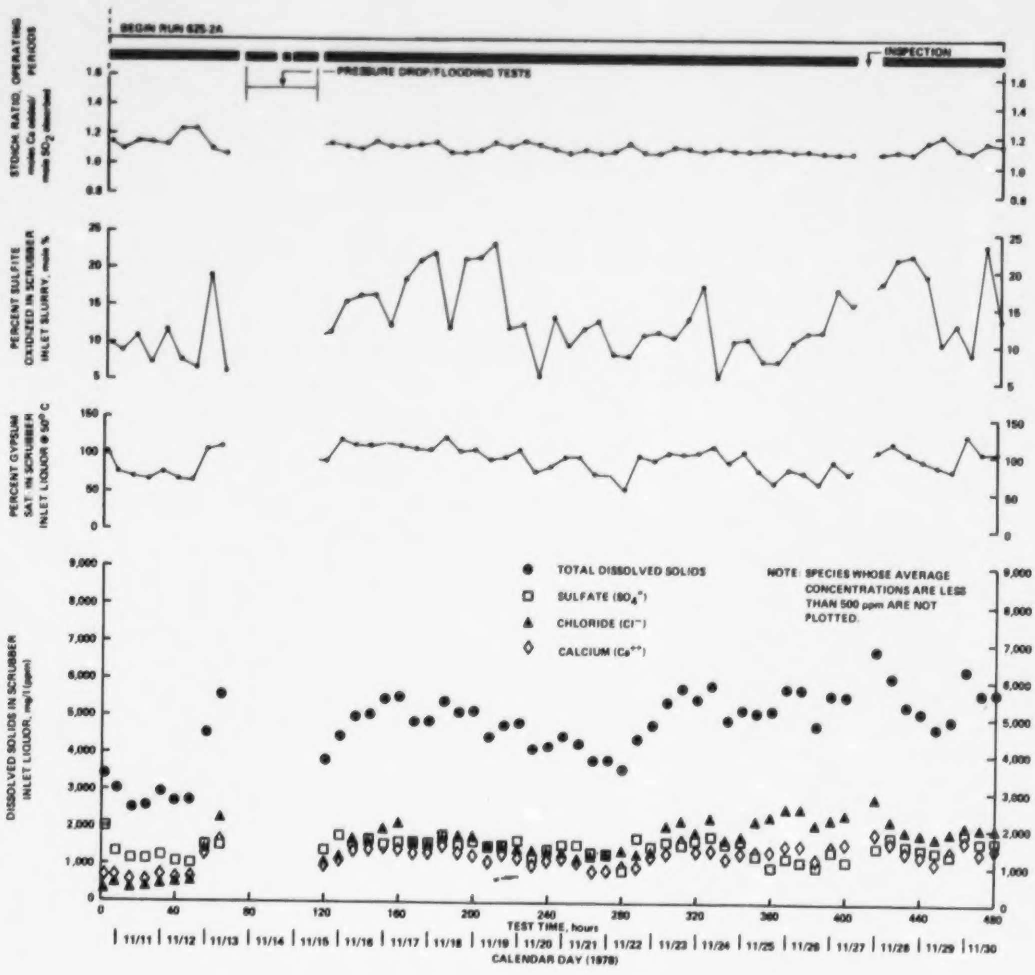


Figure I-1 (continued). Operating Data For TCA Run 625-2A

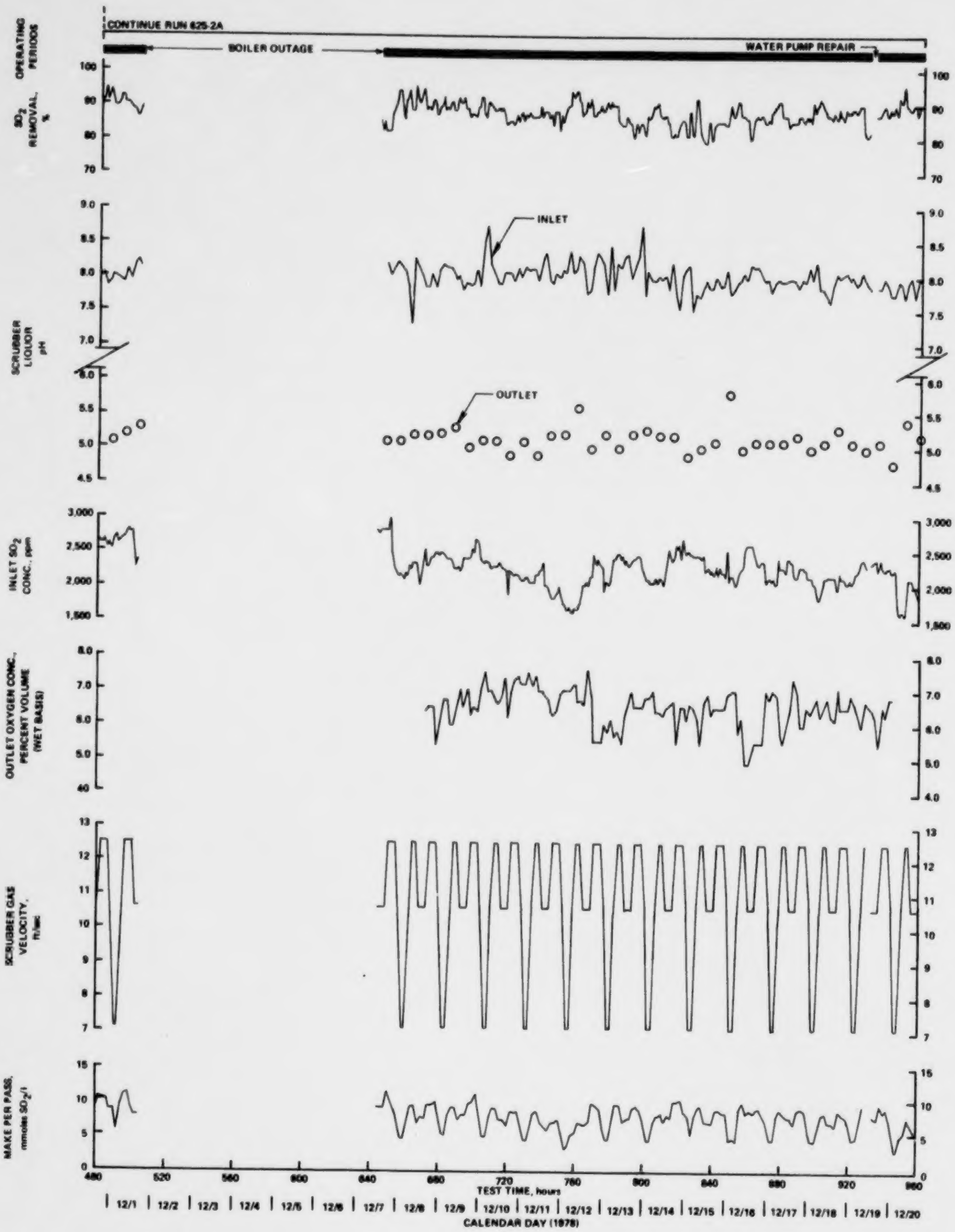


Figure I-1 (continued). Operating Data For TCA Run 625-2A

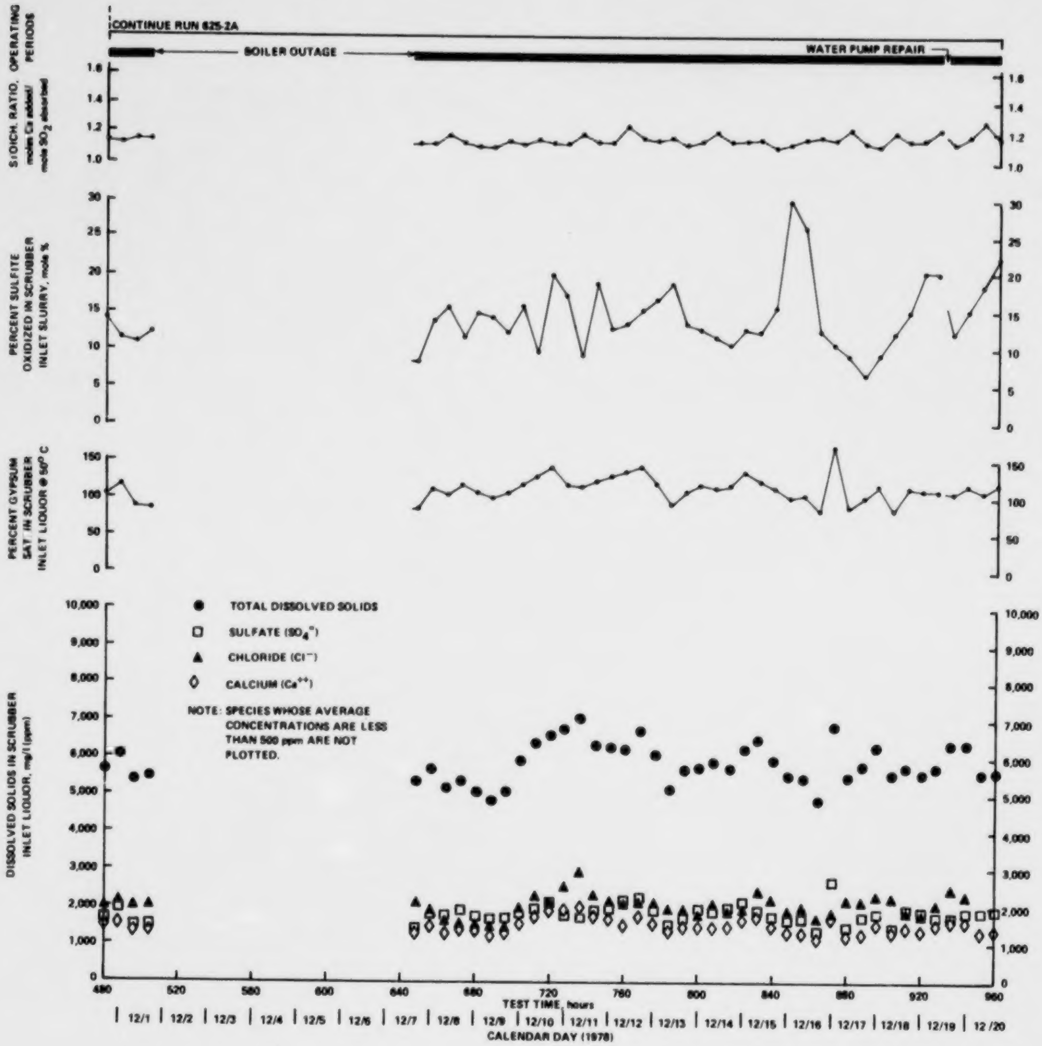


Figure I-1 (continued). Operating Data For TCA Run 625-2A

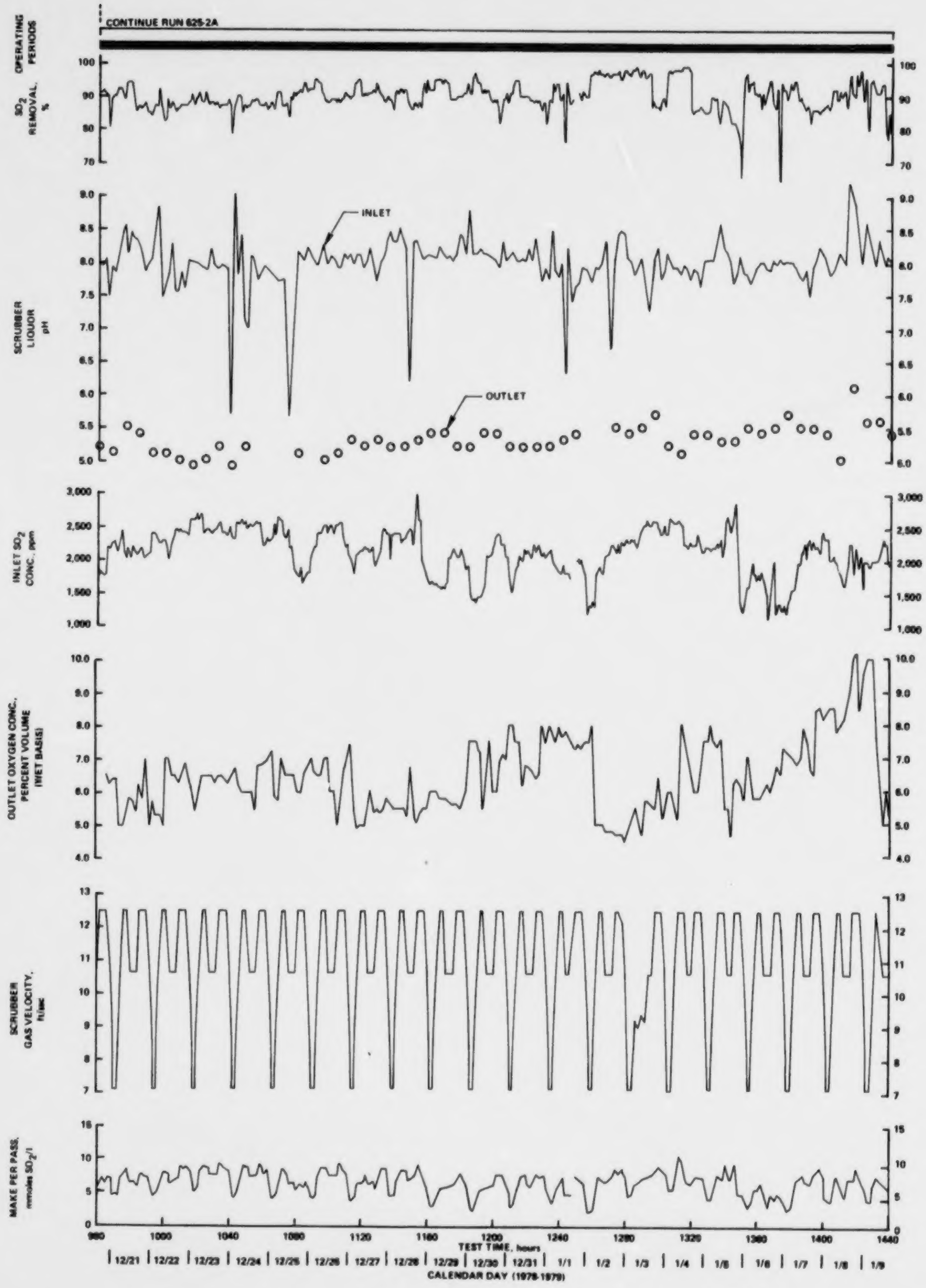


Figure I-1 (continued). Operating Data For TCA Run 625-2A

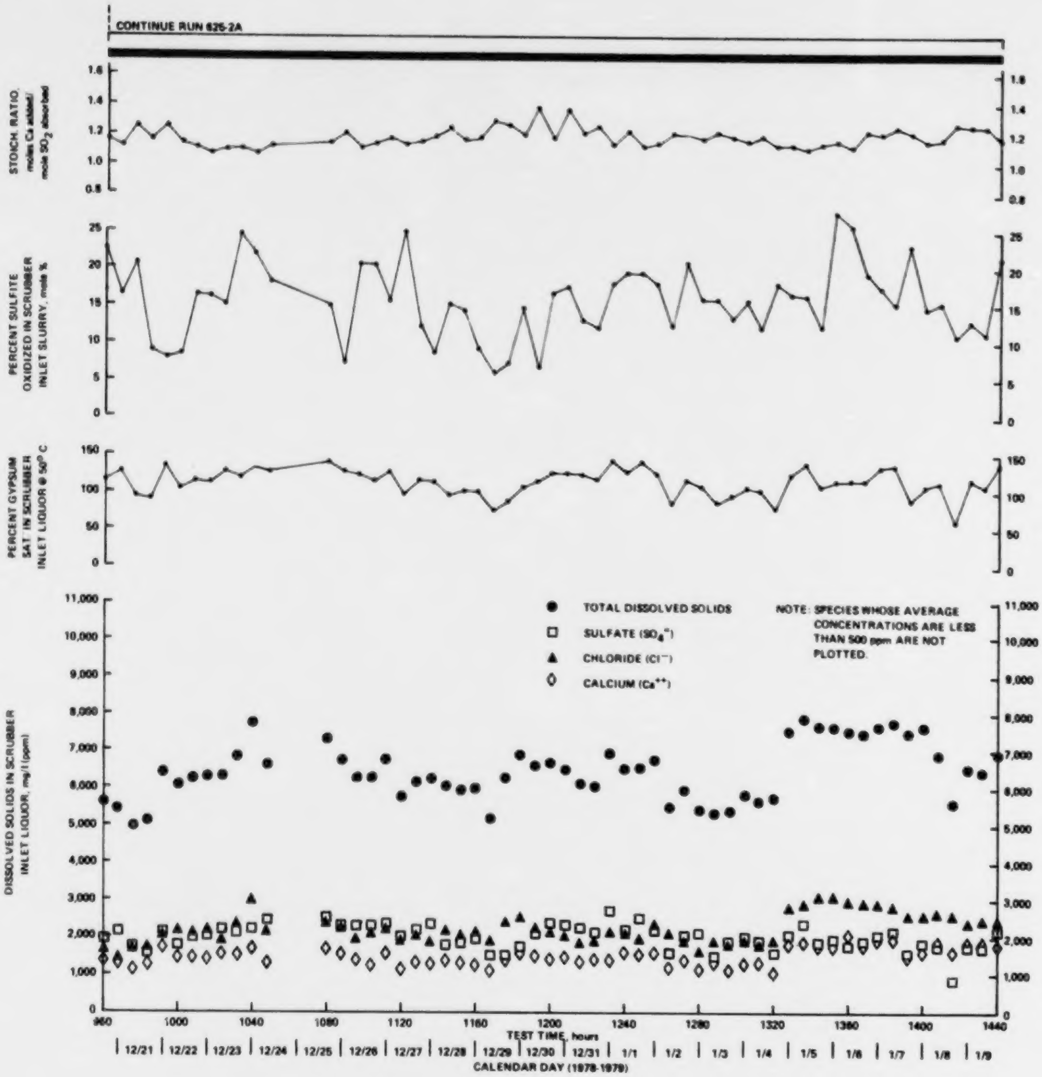


Figure I-1 (continued). Operating Data For TCA Run 625-2A

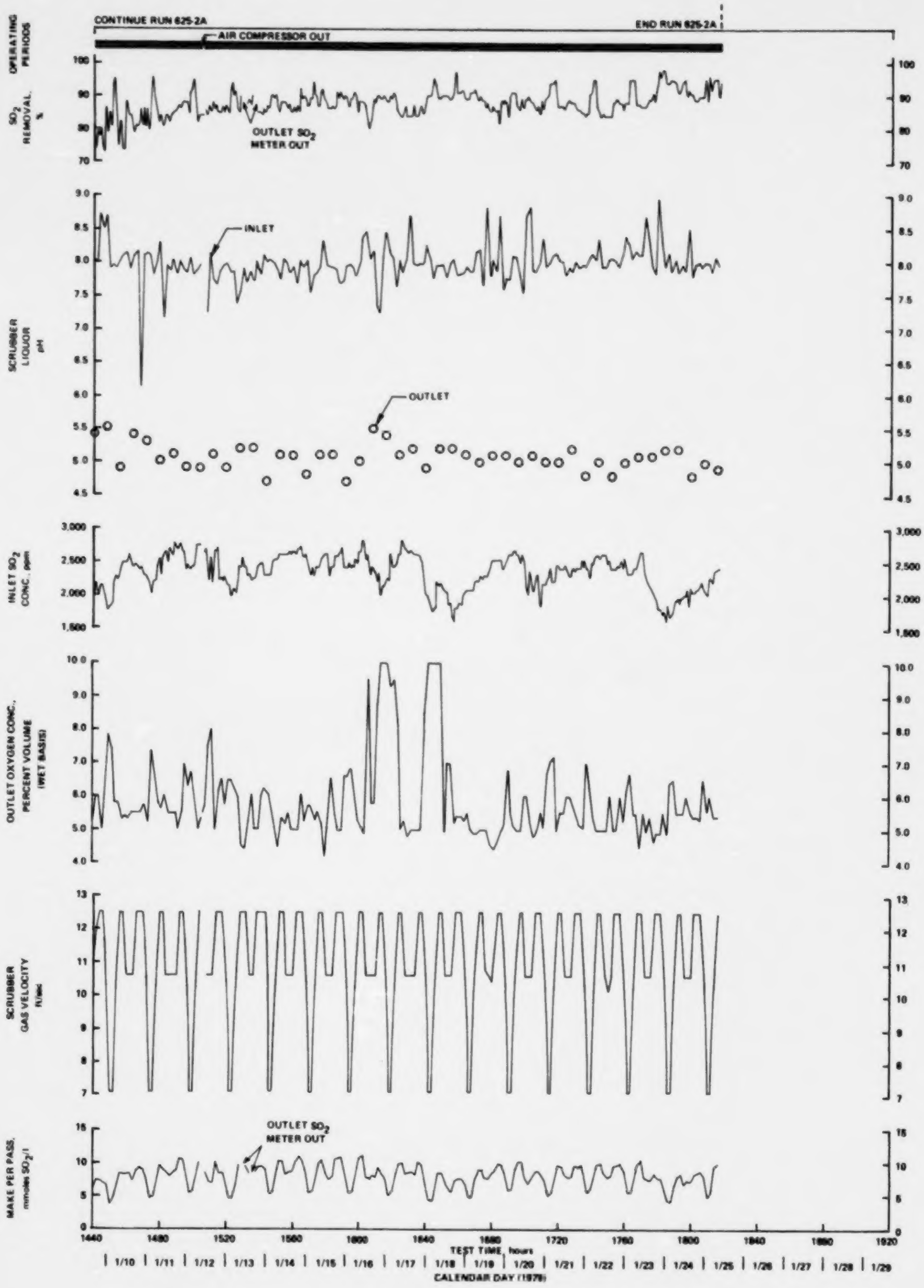
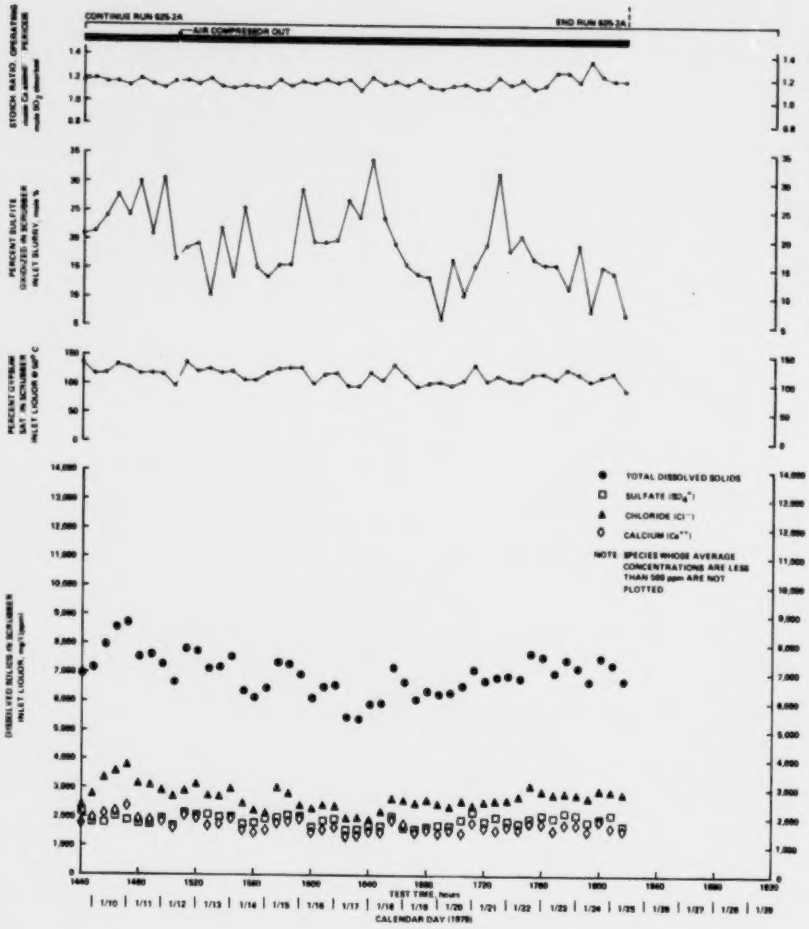


Figure I-1 (continued). Operating Data For TCA Run 625-2A



Gas Rate = 17,000 - 30,000 acfm @ 300° F
Gas Velocity = 7.1-12.5 ft/sec
Liquor Rate = 1450 gpm
L/G = 60 - 106 gal/Mcf
EHT = Residence Time = 3.4 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.0 - 9.2 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.6 - 13.7 in. H_2O
Mist Elim. Pressure Drop = 0.11 - 0.57 in. H_2O
Discharge Clarifier only Solids
Concentration = 28 - 42 wt %
Discharge (Clarifier & Centrifuge) Solids
Concentration = 52 - 63 wt %
Lime Addition to Internal Downcomer
(11/10 – 11/27) and to EHT (11/27/78 – 1/25/79)

Figure I-1 (continued). Operating Data For TCA Run 625-2A

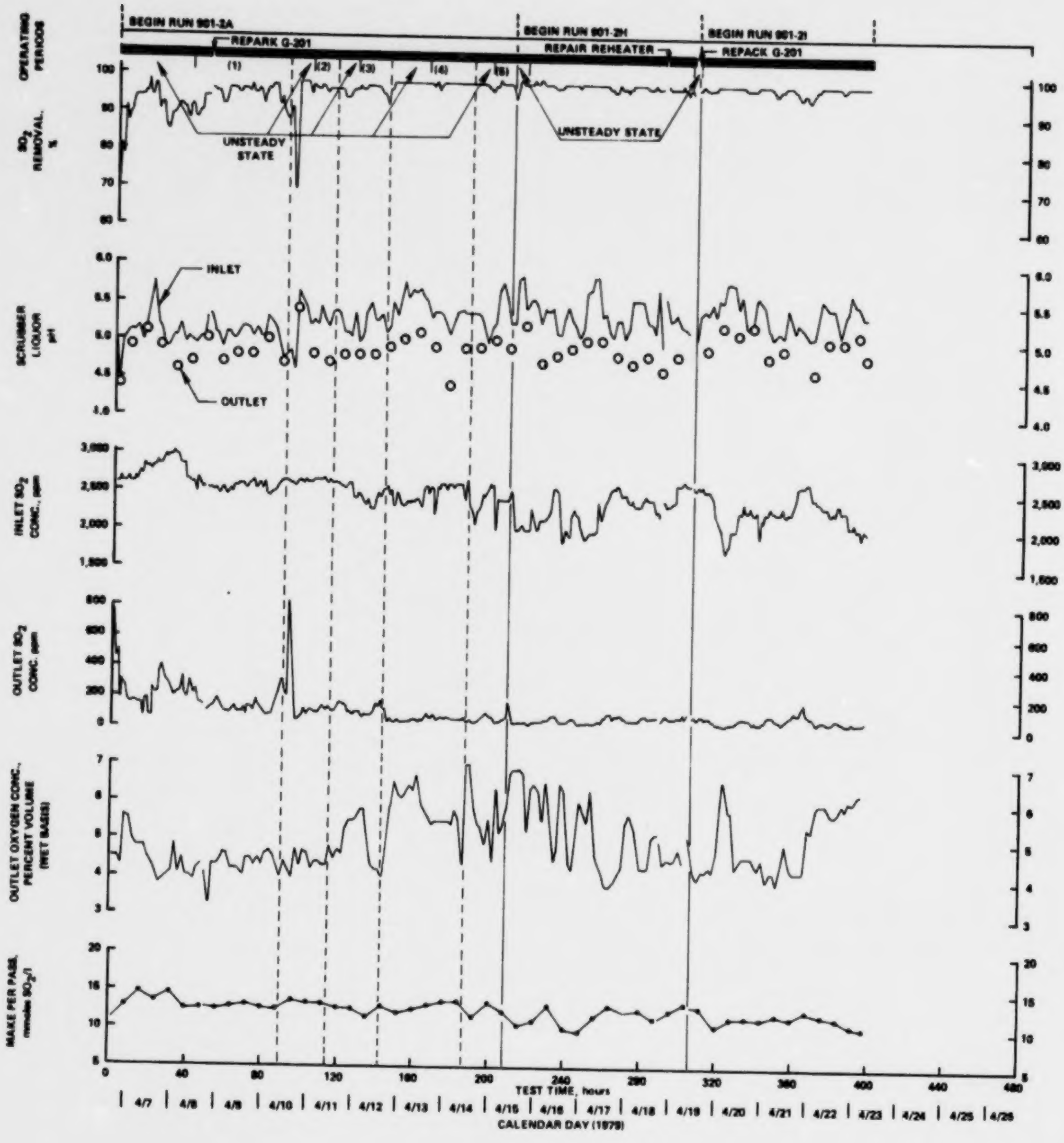
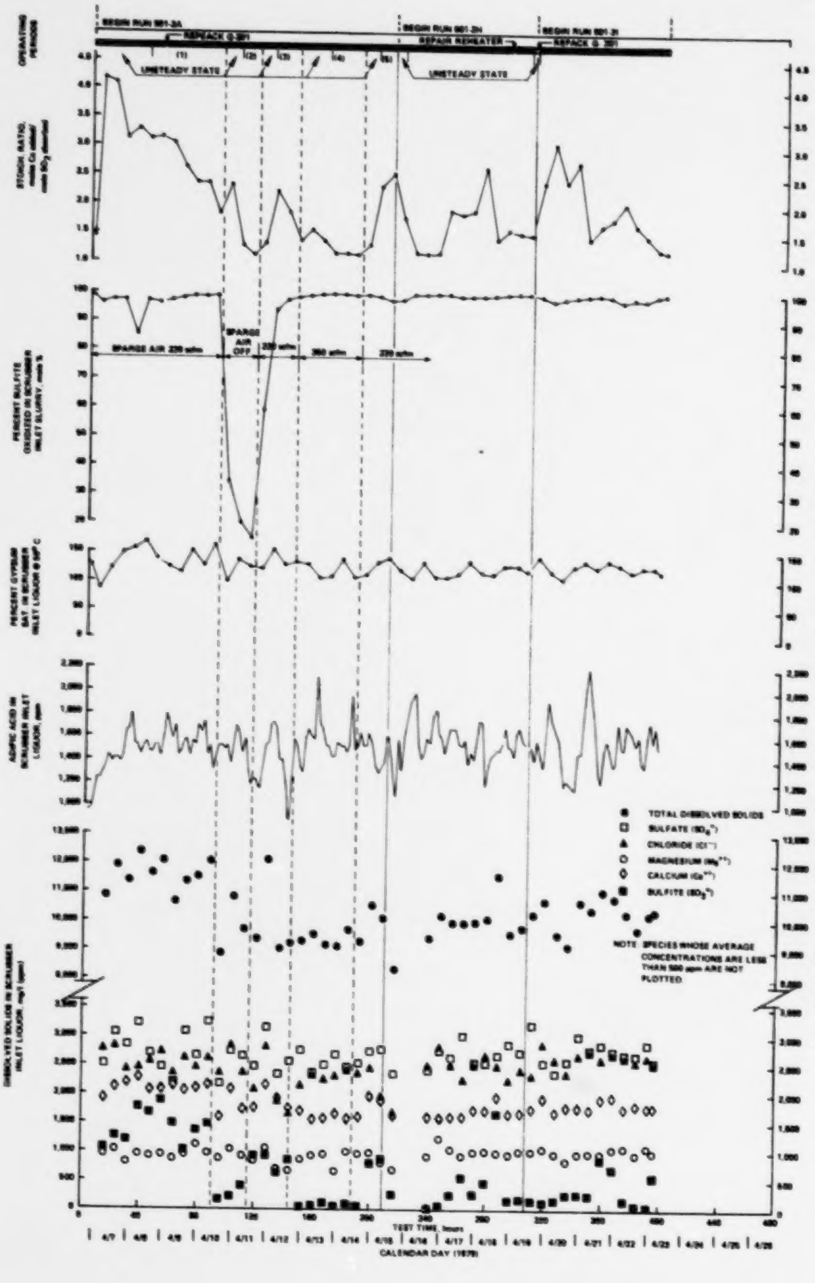


Figure I-2. Operating Data For TCA Runs 901-2A, 901-2H And 901-2I



901-2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.0 - 15.7 wt %
Limestone & Adipic Acid Addition to the Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
Concentration = 50 - 82 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.2 - 11.7 in. H_2O
Mist Elim. Pressure Drop = 0.53 - 0.62 in. H_2O
Air Flow Rate to Oxidizer = 0 to 350 scfm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

901-2H

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.3 - 16.1 wt %
Limestone Addition to the Suction of the Recirculation Pump
Adipic Acid Addition to the Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
Concentration = 74 - 80 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.2 - 9.4 in. H_2O
Mist Elim. Pressure Drop = 0.51 - 0.60 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

901-2I

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.6 - 16.4 wt %
Limestone Addition to the Suction of the Recirculation Pump
Adipic Acid Addition to the Process Water Hold Tank
Discharge (Clarifier & Centrifuge) Solids
Concentration = 75 - 81 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.9 - 9.8 in. H_2O
Mist Elim. Pressure Drop = 0.52 - 0.60 in. H_2O
Air Flow Rate to Oxidizer = 330 scfm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

Figure I-2 (continued). Operating Data For TCA Runs 901-2A, 901-2H And 901-2I

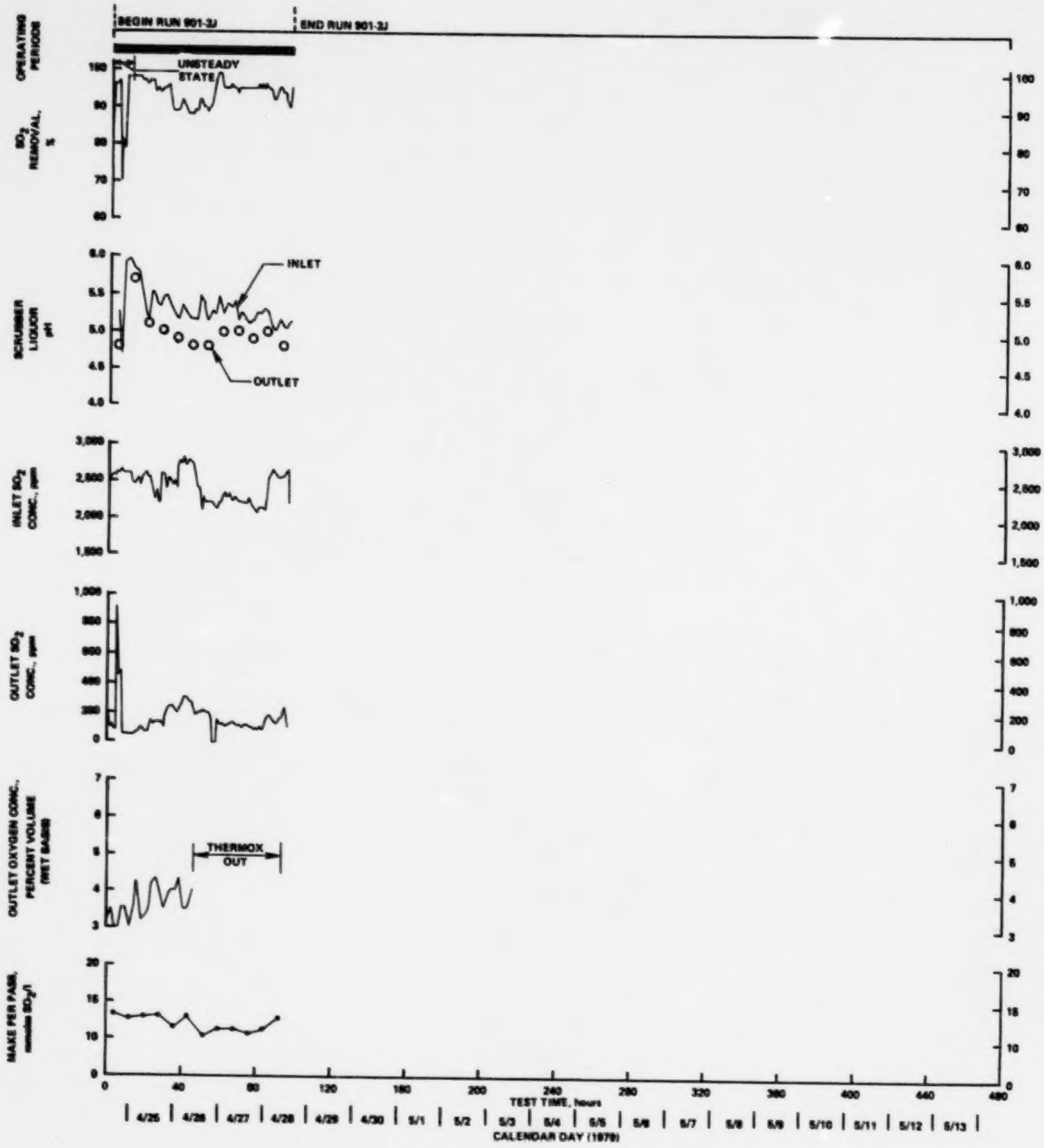
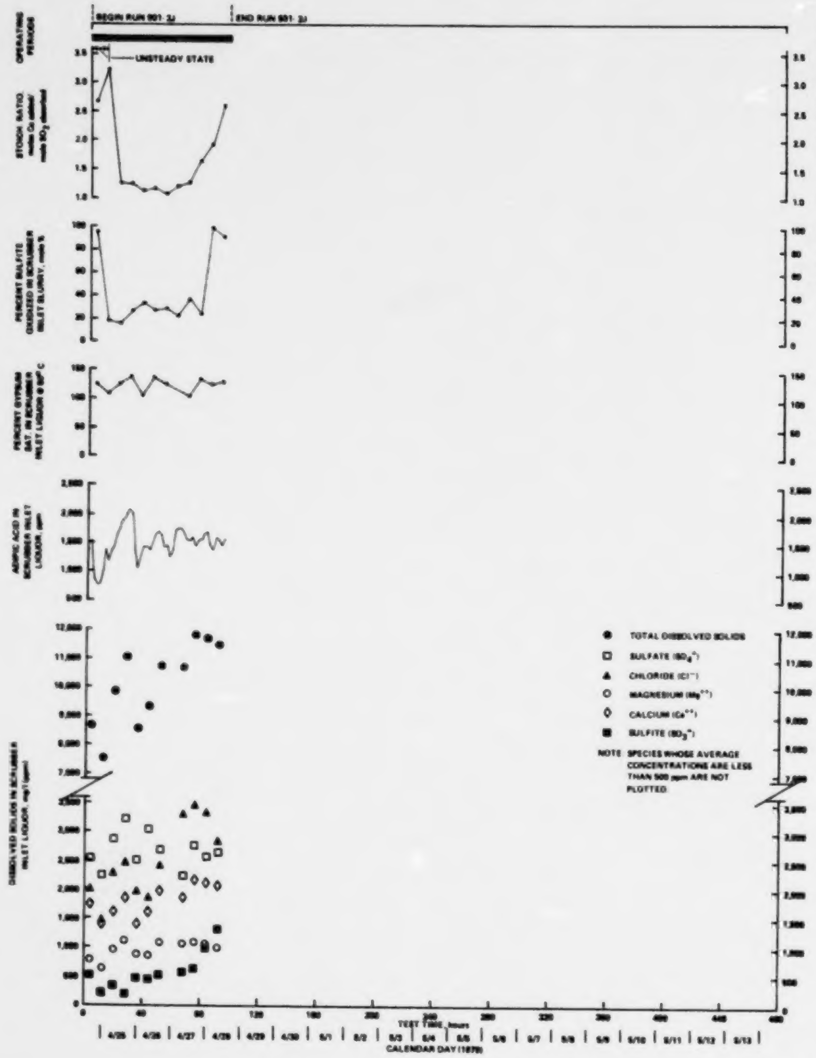


Figure I-3. Operating Data For TCA Run 901-2J



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 12.8 - 16.5 wt %
Limestone and Adipic Acid Addition to the Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
Concentration = 52 - 77 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.4 - 10.0 in. H_2O
Mist Elim. Pressure Drop = 0.50 - 0.68 in. H_2O
Air Flow Rate to Oxidizer = 0/190 scfm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

Figure I-3 (continued). Operating Data For TCA Run 901-2J

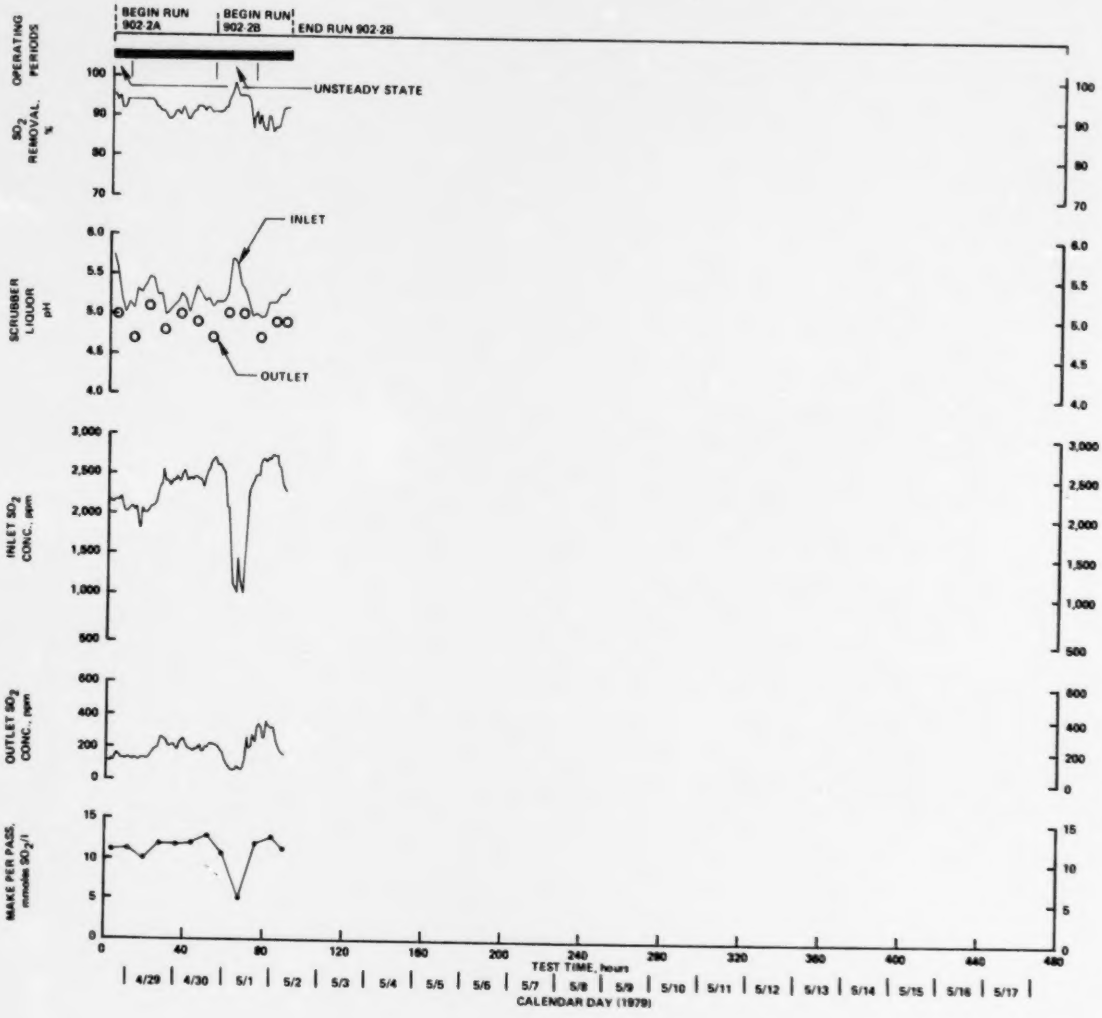
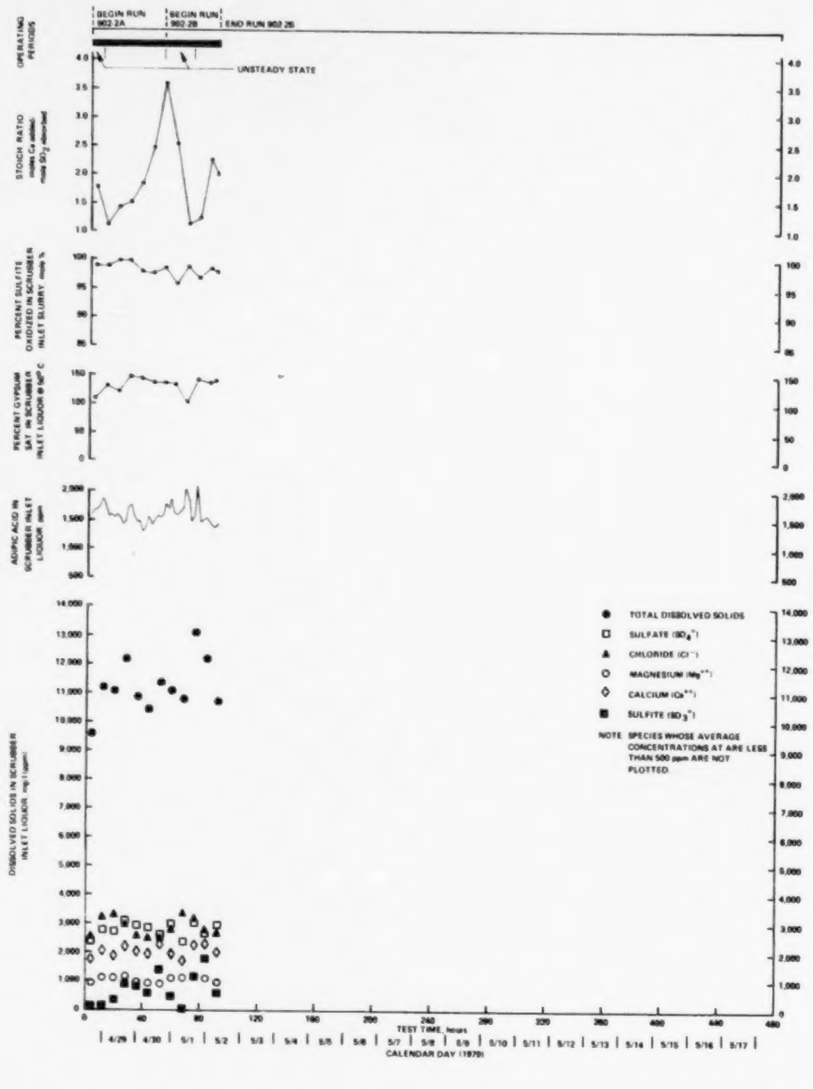


Figure I-4. Operating Data For TCA Runs 902-2A And 902-2B



902-2A

Gas Rate = 22,500 acfm @ 300° F
Gas Velocity = 9.4 ft/sec
Liquor Rate = 900 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.4 - 16.2 wt %
Limestone and Adipic Acid Addition to
  the Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
  Concentration = 77 - 78 wt %
Total Pressure Drop, Excluding Mist Elim.
  = 4.8 - 5.4 in. H_2O
Mist Elim. Pressure Drop = 0.28 - 0.35 in. H_2O
Air Stoichiometric Ratio = 1.7 atoms
  O/mole SO_2 absorbed
Oxidation Tank Residence Time = 5.4 min
Oxidation Tank Level = 17 ft

902-2B

Gas Rate = 22,500 acfm @ 300° F
Gas Velocity = 9.4 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.1 - 15.3 wt %
Limestone and Adipic Acid Addition to
  the Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
  Concentration = 74 - 79 wt %
Total Pressure Drop, Excluding Mist Elim.
  = 4.7 - 5.5 wt %
Air Stoichiometric Ratio = 1.9 atoms
  O/mole SO_2 absorbed
Oxidation Tank Residence Time = 5.4 min
Oxidation Tank Level = 17 ft

Figure I-4 (continued). Operating Data For TCA Runs 902-2A And 902-2B

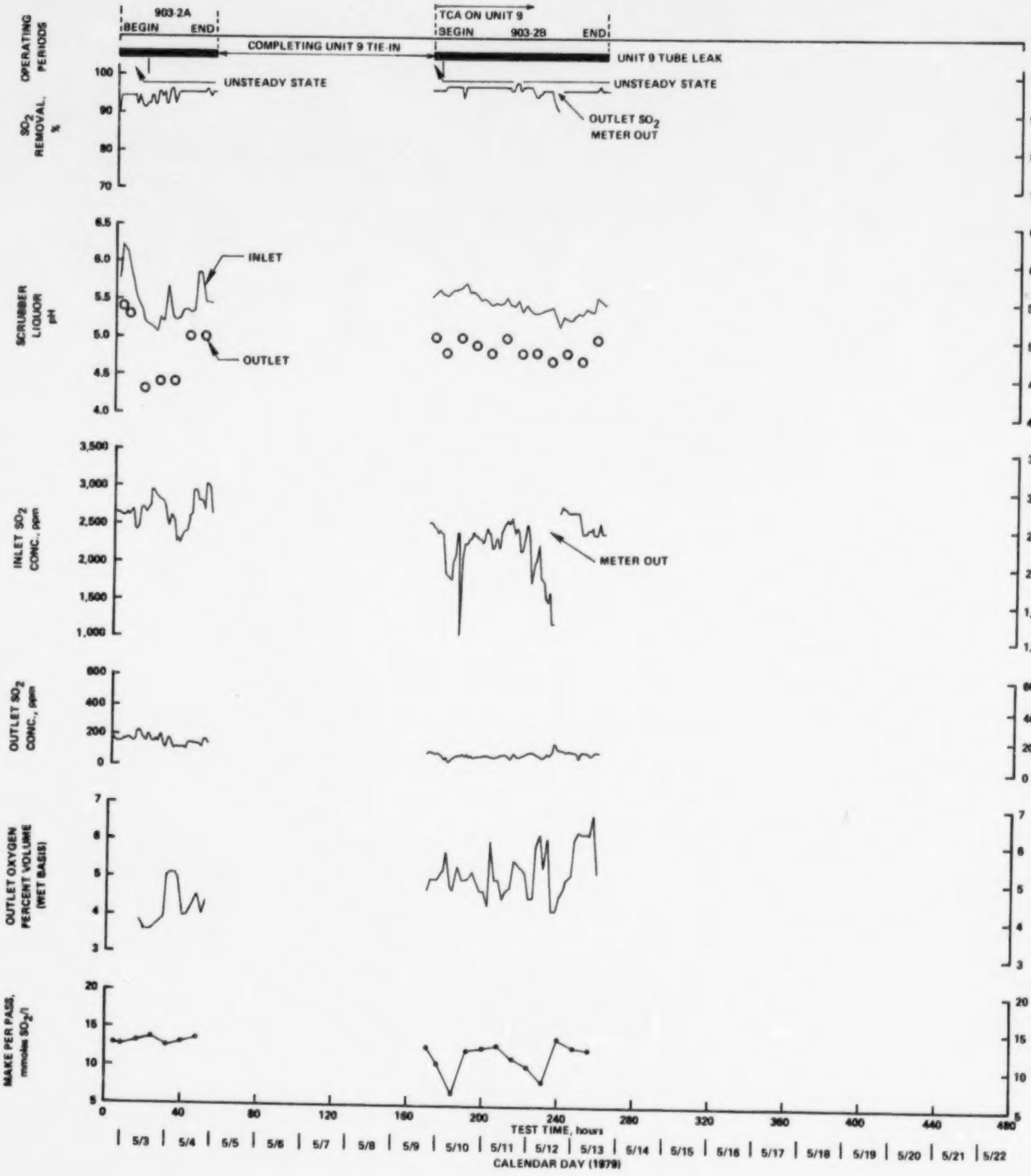
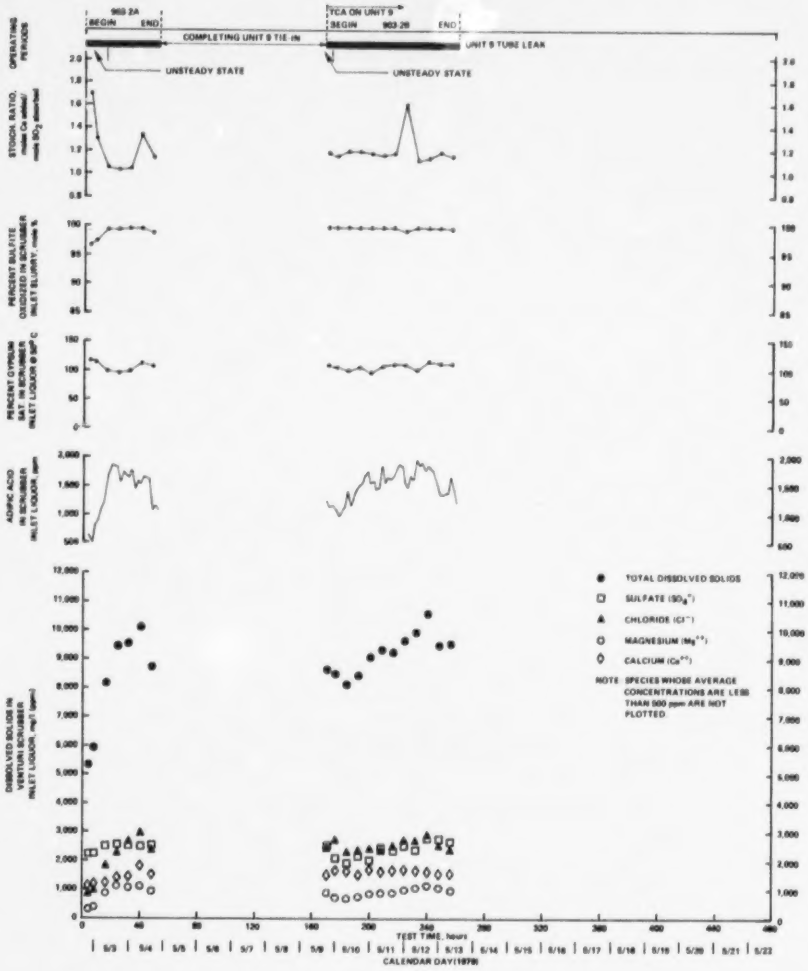


Figure I-5. Operating Data For TCA Runs 903-2A And 903-2B



903-2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.4 - 15.4 wt %
Limestone Addition to the EHT
Adipic Acid Addition to the Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
Concentration = 76 - 80 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.5 - 8.5 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Liquor Flow Rate to Oxidizer = 1200 gpm
Oxidation Tank Residence Time = 4.3 min
EHT Residence Time = 12 min
EHT Level = 6 ft 2 in.

903-2B

Gas Rate = 30,000 atm acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirci culated = 14.4 - 16.0 wt %
Limestone Addition to the EHT
Adipic Acid Additon to the Oxidation Tank
Discharge (Clarifier & Belt Filter) Solids
Concentration = 86 - 91 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.5 - 8.5 in. H_2O
Mist Elim. Pressure Drop = 0.24 - 0.35 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Oxidation Tank Residence Time = 4.3 min
EHT Residence Time = 12 min
EHT Level = 6 ft 2 in.

Figure I-5 (continued) Operating Data For TCA Runs 903-2A And 903-2B

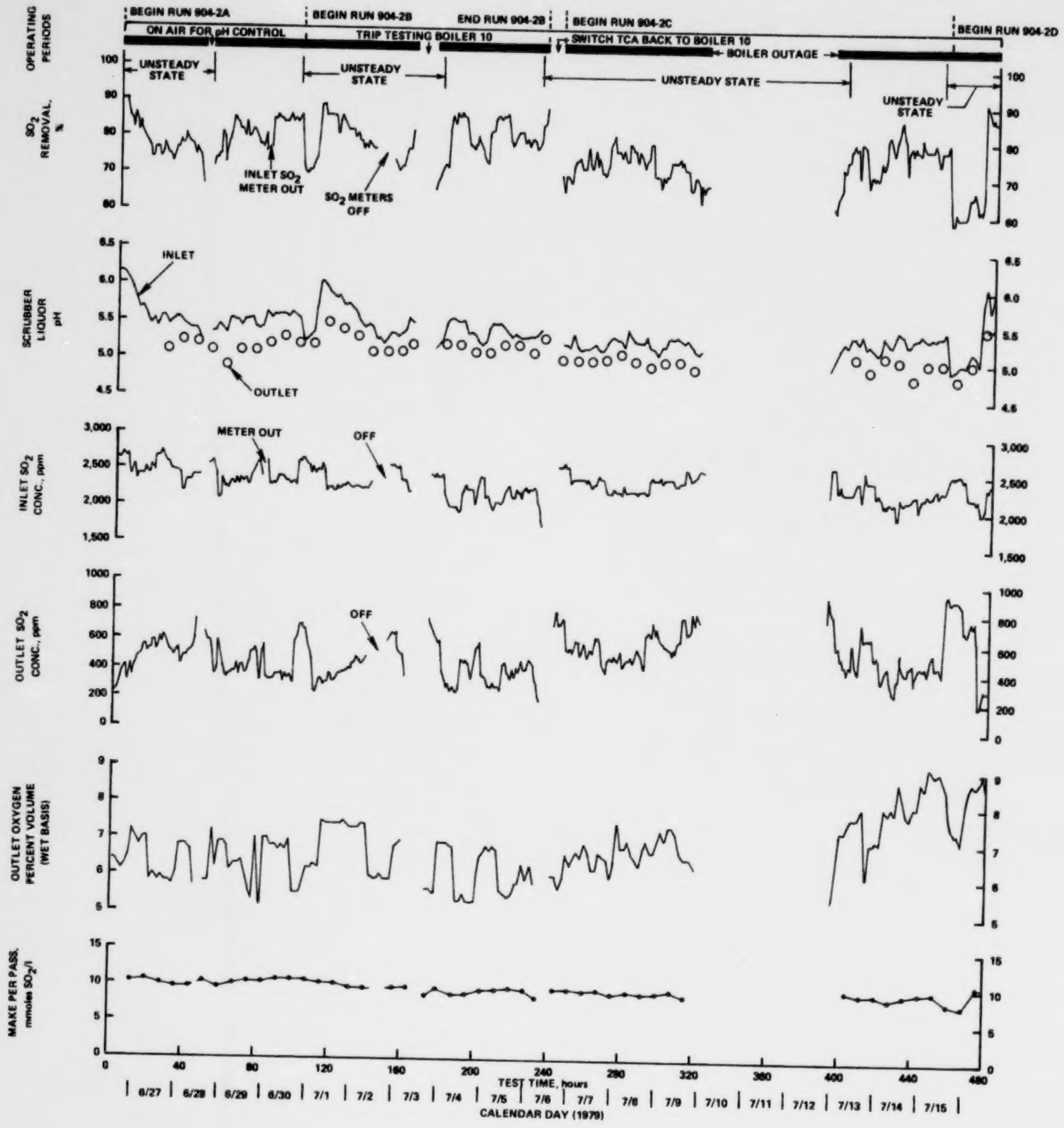
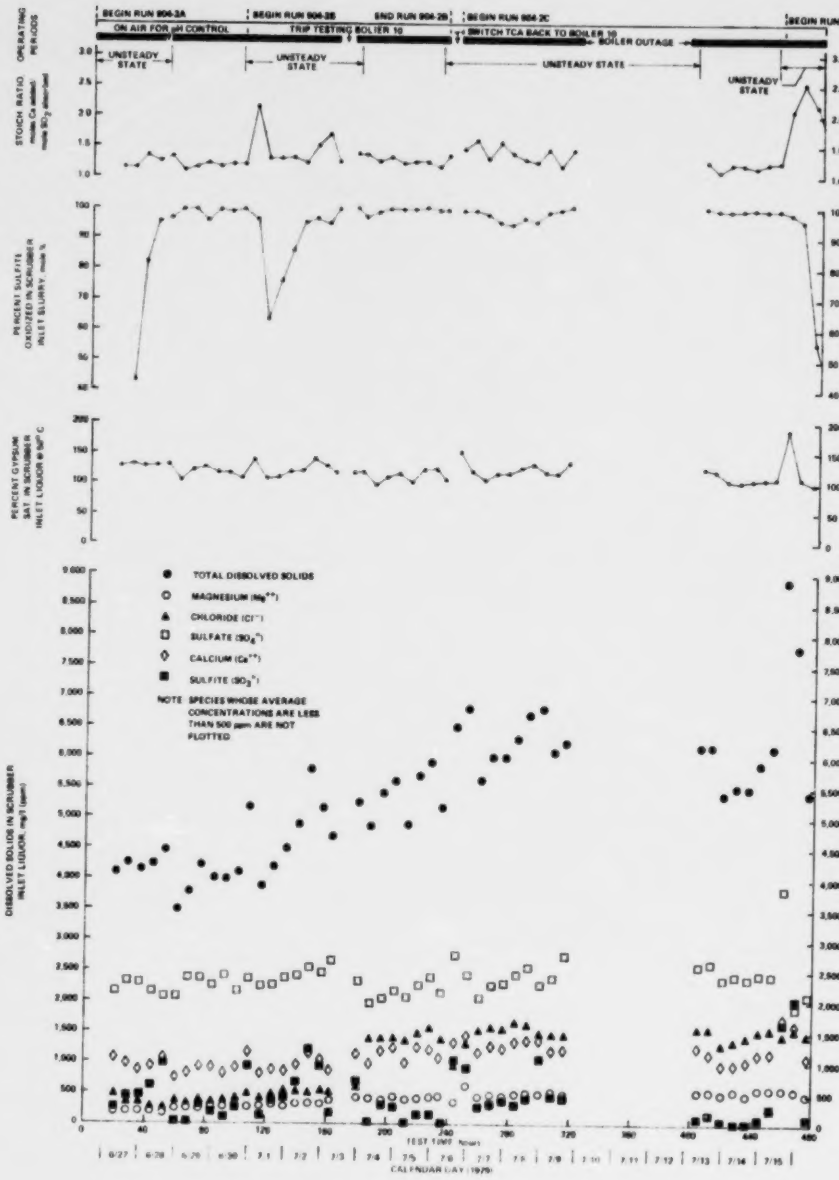


Figure I-6. Operating Data For TCA Runs 904-2A Through 904-2F



904-2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.0 - 15.8 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier & Filter) Solids
Concentration = 79 - 89 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.5 - 10.1 in. H_2O
Mist Elim. Pressure Drop = 0.25 - 0.33 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Oxidation Tank Agitator Speed = 54 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

904-2B

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.6 - 15.6 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier & Filter) Solids
Concentration = 70 - 89 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.4 - 9.9 in. H_2O
Mist Elim. Pressure Drop = 0.25 - 0.31 in. H_2O
Air Flow Rate to Oxidizer = 130 scfm
Oxidation Tank Agitator Speed = 54 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

904-2C

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.7 - 15.2 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier & Filter) Solids
Concentration = 85 - 89 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.7 - 9.8 in. H_2O
Mist Elim. Pressure Drop = 0.26 - 0.39 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Oxidation Tank Agitator Speed = 36 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

Figure I-6 (continued). Operating Data For TCA Runs 904-2A Through 904-2F

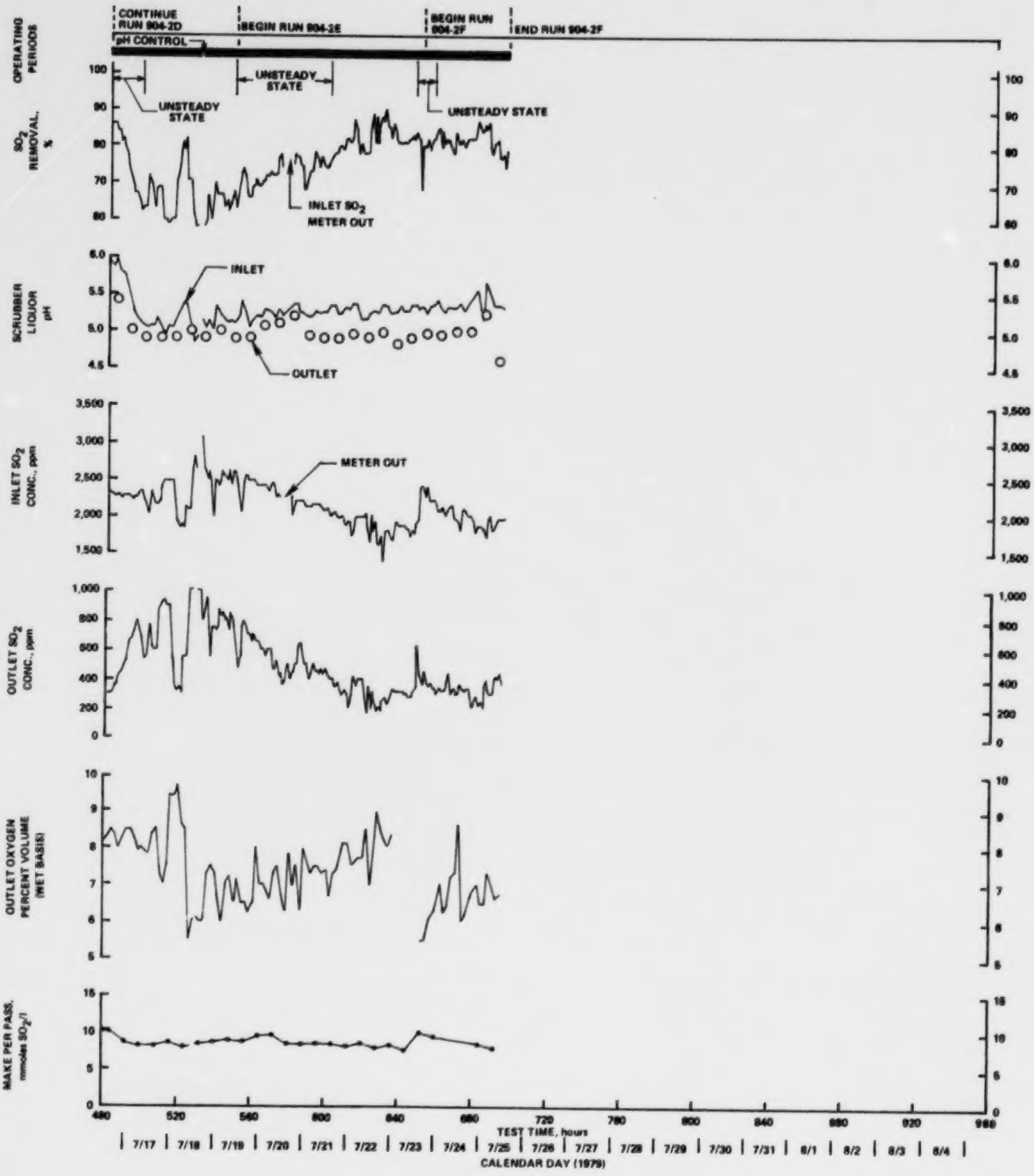
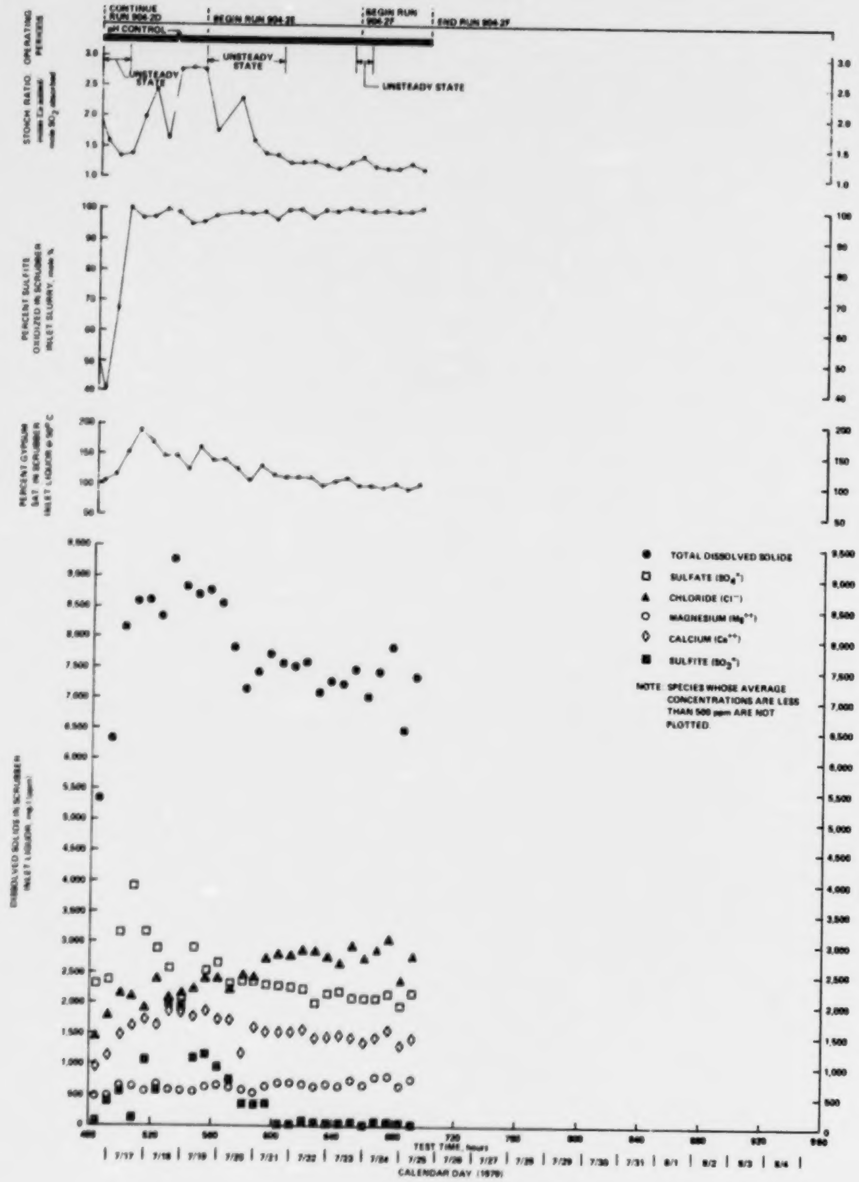


Figure I-6 (continued). Operating Data For TCA Runs 904-2A Through 904-2F



904-2D

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.8 - 15.2 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier & Filter) Solids
Concentration = 65 - 84 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.2 - 8.3 in. H_2O
Mist Elim. Pressure Drop = 0.27 - 0.32 in. H_2O
Air Flow Rate to Oxidizer = 130 scfm
Oxidation Tank Agitator Speed = 36 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

904-2E

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.5 - 15.1 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier & Filter) Solids
Concentration = 83 - 87 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.0 - 10.7 in H_2O
Mist Elim. Pressure Drop = 0.24 = 0.35 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Oxidation Tank Agitator Speed = 18 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

904-2F

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sce sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.5 - 15.9 wt %
Limestone Addition to Oxidation Tank
Discharge (Clarifier & Filter) Solids
Concentration = 85 - 86 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.0 - 9.0 in. H_2O
Mist Elim. Pressure Drop = 0.26 - 0.33 in. H_2O
Air Flow Rate to Oxidizer = 350 scfm
Oxidation Tank Agitator Speed = 18 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

Figure I-6 (continued). Operating Data For TCA Runs 904-2A Through 904-2F

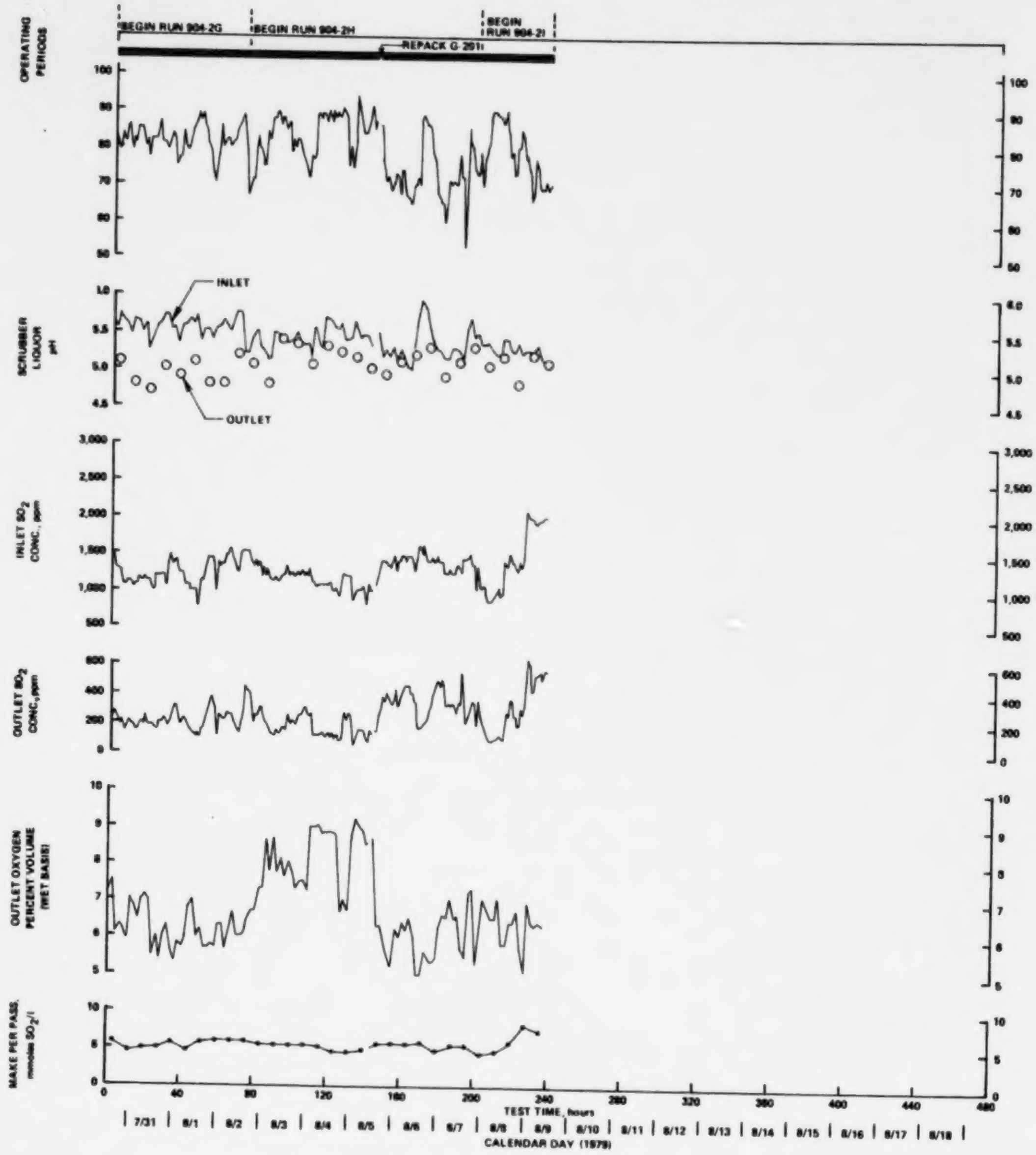
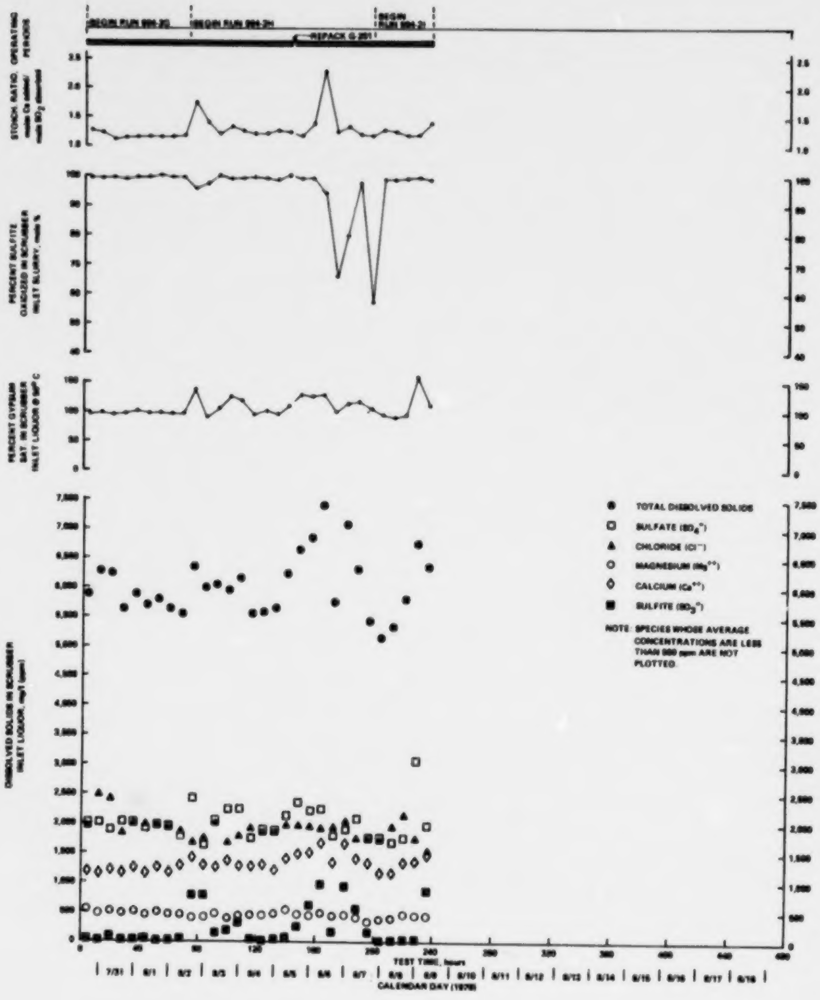


Figure I-7. Operating Data For TCA Runs 904-2G Through 904-2I



904-2G

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.4 - 16.2 wt %
Limestone Addition to the Oxidation Tank
Discharge (Clarifier only) Solids
Concentration = 37 - 49 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.9 - 9.0 in. H_2O
Mist Elim. Pressure Drop = 0.26 - 0.32 in. H_2O
Air Flow Rate to Oxidizer = 350 scfm
Oxidation Tank Agitator Speed = 36 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

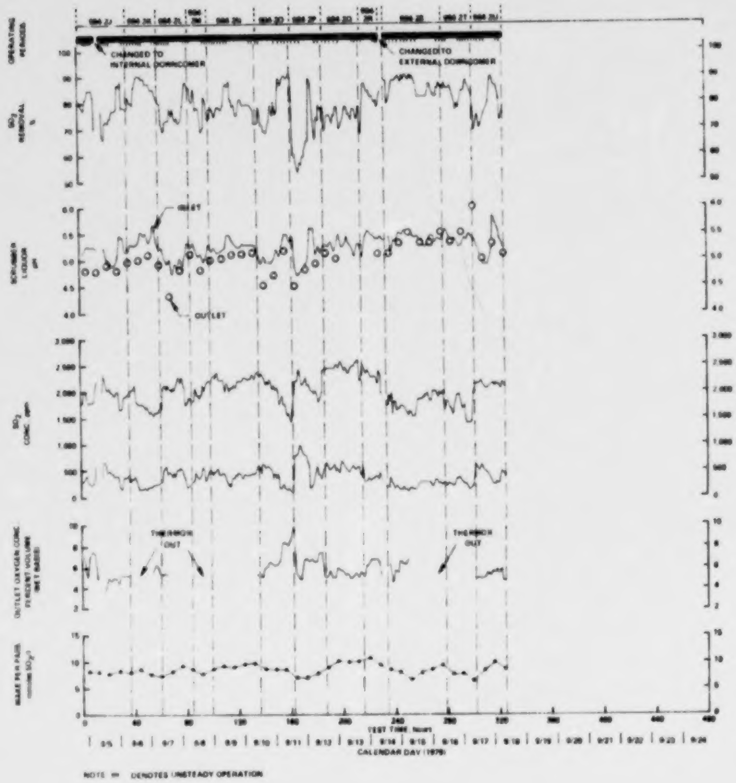
904-2H

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.0 - 16.2 wt %
Limestone Addition to the Oxidation Tank
Discharge (Clarifier only) Solids
Concentration = 30 - 48 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.9 - 8.9 in. H_2O
Mist Elim. Pressure Drop = 0.28 - 0.33 in. H_2O
Air Flow Rate to Oxidizer = 47 - scfm
Oxidation Tank Agitator Speed = 36 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

904-2I

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated 14.6 wt %
Limestone Addition to the Oxidation Tank
Discharge (Clarifier only) Solids
Concentration = 32 - 36 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.2 - 8.9 in. H_2O
Mist Elim. Pressure Drop = 0.29 - 0.32 in. H_2O
Air Flow Rate to Oxidizer = 47 scfm
Oxidation Tank Agitator Speed = 54 rpm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

Figure I-7 (continued). Operating Data For TCA Runs 904-2G Through 904-2I



904-2J through 904-2U

Gas Rate = 30,000 acfm @ 300°F

Gas Velocity = 12.5 ft/sec @ 125°F

Liquor Rate = 1200 gpm

L/G = 50 gal/Mcf

3 Beds, 5 in. spheres/bed

Oxidation Tank Residence Time = 4.1 min

Oxidation Tank Level = 17 ft

Limestone Addition to the Oxidation Tank

904-2J

Percent Solids Recirculated = 14.3 - 15.6 wt %

Discharge (Clarifier & Filter) Solids Concentration = 83 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.5 - 9.4 in. H_2O

Mist Elim. Pressure Drop = 0.28 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 109 scfm

Oxidation Tank Agitator Speed = 54 rpm

904-2K

Percent Solids Recirculated = 14.9 wt %

Discharge (Clarifier & Filter) Solids Concentration = 81 - 84 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.9 - 9.0 in. H_2O

Mist Elim. Pressure Drop = 0.29 - 0.31 in. H_2O

Air Flow Rate to Oxidizer = 134 scfm

Oxidation Tank Agitator Speed = 54 rpm

904-2L

Percent Solids Recirculated = 13.8 wt %

Discharge (Clarifier & Filter) Solids Concentration = 81 - 82 wt %

Total Pressure Drop, Exluding Mist Elim. = 8.7 - 8.8 in. H_2O

Mist Elim. Pressure Drop = 0.27 - 0.29 in. H_2O

Air Flow Rate to Oxidizer = 139 scfm

Oxidation Tank Agitator Speed = 54 rpm

904-2M

Percent Solids Recirculated = 15.9 wt %

Discharge (Clarifier & Filter) Solids Concentration = 79 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.3 - 8.9 in. H_2O

Mist Elim. Pressure Drop = 0.26 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 165 scfm

Oxidation Tank Agitator Speed = 36 rpm

904-2N

Percent Solids Recirculated = 13.0 - 15.2 wt %

Discharge (Clarifier & Filter) Solids Concentration = 80 wt %

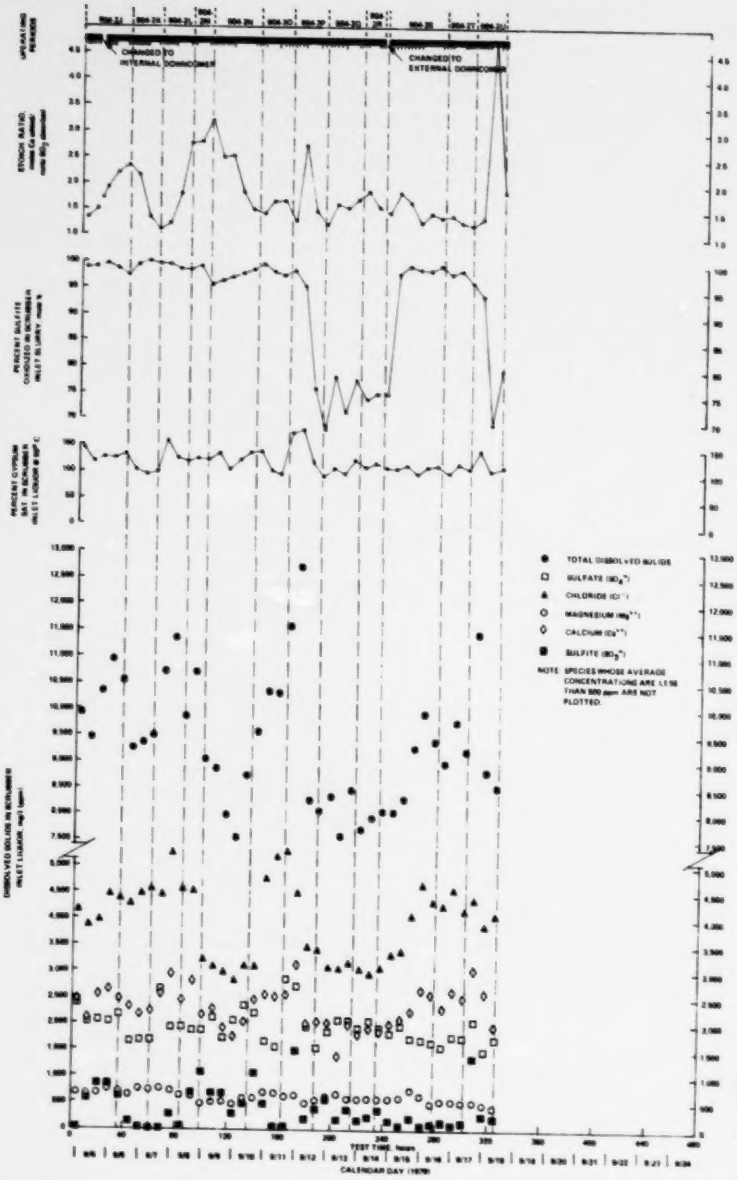
Total Pressure Drop, Excluding Mist Elim. = 8.3 - 9.2 in. H_2O

Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 231 scfm

Oxidation Tank Agitator Speed = 36 rpm

Figure I-8. Operating Data For TCA Runs 904-2J Through 904-2U



904-2O
Percent Solids Recirculated = 14.8 wt %
Discharge (Clarifier & Filter) Solids Concentration = 86 wt %
Total Pressure Drop, Excluding Mist Elim. = 8.8 - 9.2 in. H_2O
Mist Elim. Pressure Drop = 0.29 - 0.32 in. H_2O
Air Flow Rate to Oxidizer = 188 scfm
Oxidation Tank Agitator Speed = 36 rpm

904-2P
Percent Solids Recirculated = 13.2 wt %
Discharge (Clarifier & Filter) Solids
Total Pressure Drop, Excluding Mist Elim. = 8.4 - 9.3 in. H_2O
Mist Elim. Pressure Drop = 0.28 - 0.32 in. H_2O
Air Flow Rate to Oxidizer = 178 scfm
Oxidation Tank Agitator Speed = 18 rpm

904-2Q
Percent Solids Recirculated = 14.6 - 15.5 wt %
Discharge (Clarifier & Filter) Solids Concentration = 70 - 72 wt %
Total Pressure Drop, Excluding Mist Elim. = 9.1 - 9.6 in. H_2O
Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O
Air Flow Rate to Oxidizer = 274 scfm
Oxidation Tank Agitator Speed = 18 rpm

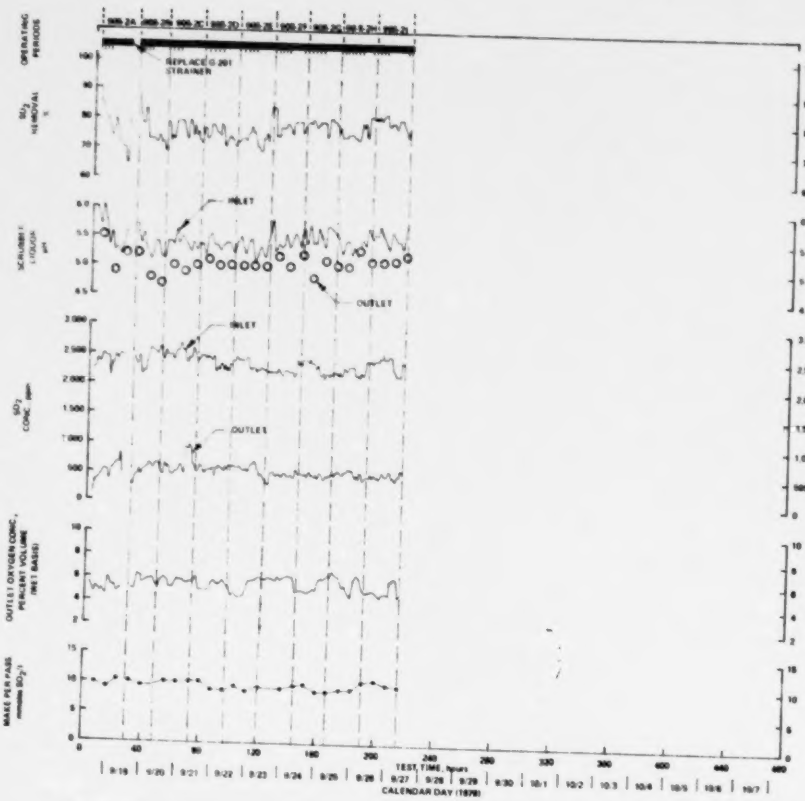
904-2R
Percent Solids Recirculated = 15.0 wt %
Discharge (Clarifier & Filter) Solids Concentration = 70 wt %
Total Pressure Drop, Exluding Mist Elim. = 8.7 - 10.0 in. H_2O
Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O
Air Flow Rate to Oxidizer = 138 scfm
Oxidation Tank Agitator Speed = 18 rpm

904-2S
Percent Solids Recirculated = 14.8 - 16.4 wt %
Discharge (Clarifier & Filter) Solids Concentration = 85 - 89 wt %
Total Pressure Drop, Excluding Mist Elim. = 8.4 - 9.3 in. H_2O
Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O
Air Flow Rate to Oxidizer = 138 scfm
Oxidation Tank Agitator Speed = 54 rpm

904-2T
Percent Solids Recirculated = 14.4 - 14.9 wt %
Discharge (Clarifier & Filter) Solids Concentration = 78 - 85 wt %
Total Pressure Drop, Excluding Mist Elim. = 8.5 - 9.0 in. H_2O
Mist Elim. Pressure Drop = 0.24 - 0.30 in. H_2O
Air Flow Rate to Oxidizer = 175 scfm
Oxidation Tank Agitator Speed = 36 rpm

904-U
Percent Solids Recirculated = 12.3 wt %
Discharge (Clarifier & Filter) Solids
Total Pressure Drop, Excluding Mist Elim. = 8.9 - 9.2 in. H_2O
Mist Elim. Pressure Drop = 0.29 - 0.30 in. H_2O
Air Flow Rate to Oxidizer = 245 scfm
Oxidation Tank Agitator Speed = 18 rpm

Figure I-8 (continued). Operating Data For TCA Runs 904-2J Through 904-2U



NOTE ═ DENOTES UNSTEADY STATE OPERATION

905-2A through 905-2I

Gas Rate = 30,000 acfm @ 300°F

Gas Velocity = 12.5 ft/sec @ 125°F

Liquor Rate = 1200 gpm

L/G = 50 gal/Mcf

3 Beds, 5 in. spheres/bed

Oxidation Tank Residence Time = 4.1 min

Oxidation Tank Level = 17 ft

905-2A

Percent Solids Recirculated = 15.3 - 15.4 wt %

Discharge (Clarifier & Filter) Solids Concentration = 57 - 61 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.7 - 9.4 in. H_2O

Mist Elim. Pressure Drop = 0.27 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 0 scfm

Oxidation Tank Agitator Speed = 54 rpm

905-2B

Percent Solids Recirculated = 15.7 - 15.9 wt %

Discharge (Clarifier & Filter) Solids Concentration = 64 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.9 - 9.2 in. H_2O

Mist Elim. Pressure Drop = 0.27 - 0.31 in. H_2O

Air Flow Rate to Oxidizer = 62 scfm

Oxidation Tank Agitator Speed = 54 rpm

905-2C

Percent Solids Recirculated = 14.6 - 16.8 wt %

Discharge (Clarifier & Filter) Solids Concentration = 63 - 64 wt %

Total Pressure Drop, Excluding Mist Elim. = 9.0 - 9.6 in. H_2O

Mist Elim. Pressure Drop = 0.27 - 0.32 in. H_2O

Air Flow Rate to Oxidizer = 79 scfm

Oxidation Tank Agitator Speed = 54 rpm

905-2D

Percent Solids Recirculated = 13.9 - 14.7 wt %

Discharge (Clarifier & Filter) Solids Concentration = 69 - 87 wt %

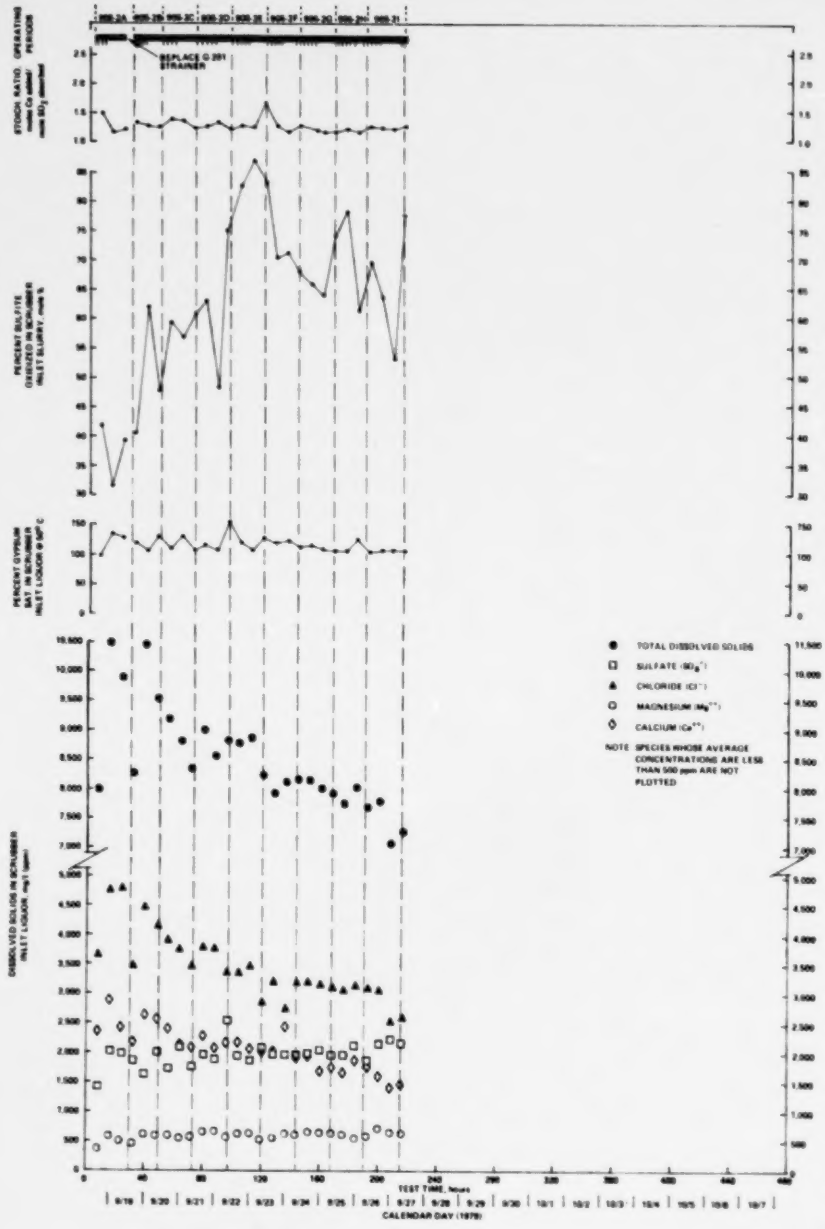
Total Pressure Drop, Excluding Mist Elim. = 8.7 - 9.3 in. H_2O

Mist Elim. Pressure Drop = 0.25 - 0.29 in. H_2O

Air Flow Rate to Oxidizer = 102 scfm

Oxidation Tank Agitator Speed = 54 rpm

Figure I-9. Operating Data For TCA Runs 905-2A Through 905-2I



905-2E

Percent Solids Recirculated = 14.4 - 15.6 wt %

Discharge (Clarifier & Filter) Solids Concentration = 69 - 79 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.3 - 9.2 in. H_2O

Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 137 scfm

Oxidation Tank Agitator Speed = 54 rpm

905-2F

Percent Solids Recirculated = 14.6 wt %

Discharge (Clarifier & Filter) Solids Concentration = 64 - 73 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.6 - 9.1 in. H_2O

Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 138 scfm

Oxidation Tank Agitator Speed = 36 rpm

905-2G

Percent Solids Recirculated = 15.6 - 16.4 wt %

Discharge (Clarifier & Filter) Solids Concentration = 66 - 69 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.9 - 9.6 in. H_2O

Mist Elim. Pressure Drop = 0.25 - 0.30 in. H_2O

Air Flow Rate to Oxidizer = 151 scfm

Oxidation Tank Agitator Speed = 36 rpm

905-2H

Percent Solids Recirculated = 14.9 - 15.3 wt %

Discharge (Clarifier & Filter) Solids Concentration = 69 - 72 wt %

Total Pressure Drop, Excluding Mist Elim. = 8.9 - 9.4 in H_2O

Mist Elim. Pressure Drop = 0.26 - 0.34 in H_2O

Air Flow Rate to Oxidizer = 174 scfm

Oxidation Tank Agitator Speed = 36 rpm

905-2I

Percent Solids Recirculated = 15.4 wt %

Discharge (Clarifier & Filter) Solids Concentration = 66 - 70 wt %

Total Pressure Drop, Excluding Mist Elim. = 9.0 - 9.6 in H_2O

Mist Elim. Pressure Drop = 0.26 - 0.32 in. H_2O

Air Flow Rate to Oxidizer = 202 scfm

Oxidation Tank Agitator Speed = 36 rpm

Figure I-9 (continued). Operating Data For TCA Runs 905-2A Through 905-2I

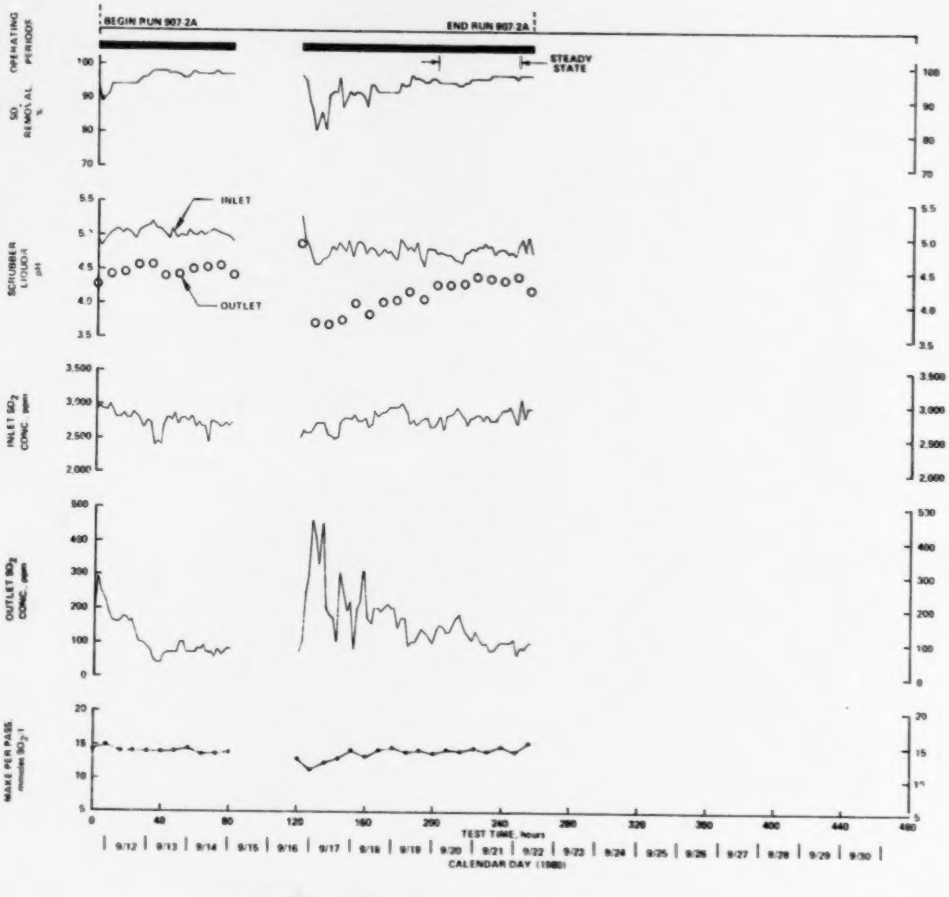
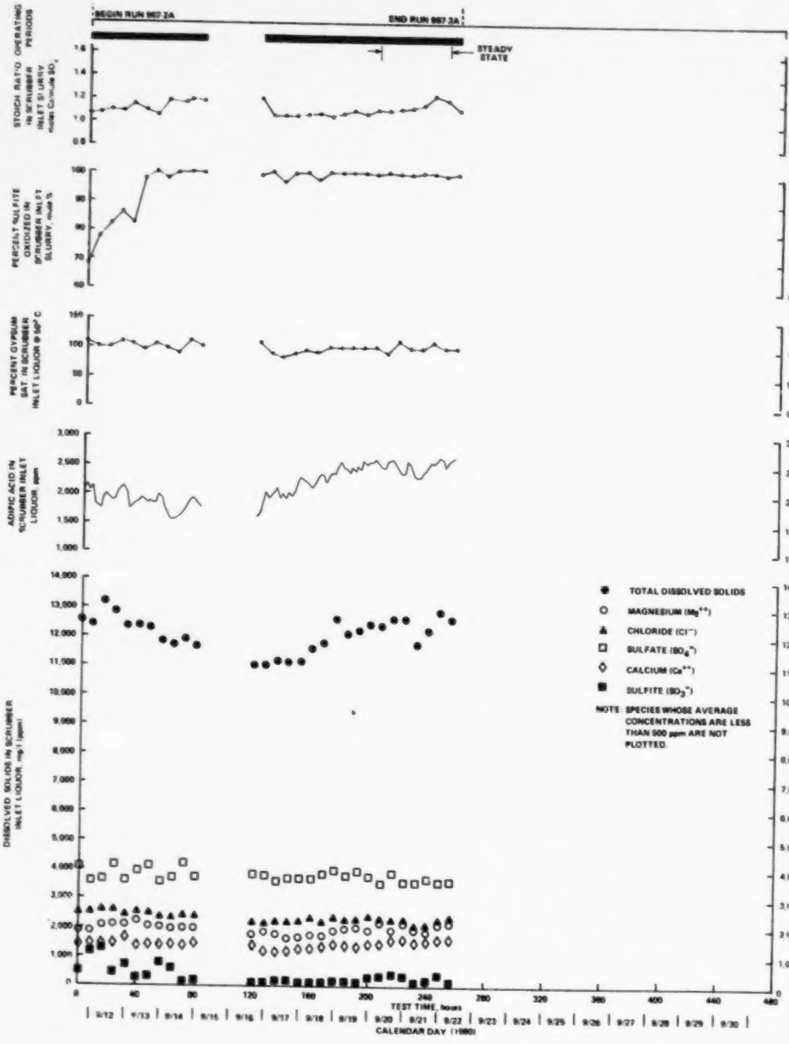


Figure I-10. Operating Data For TCA Run 907-2A



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 35 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 8.9-11.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.8-11.6 in. H_2O
Mist Elim. Pressure Drop = 0.29-0.32 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 81-93 wt %
Clarified Liquor Returned to EHT

Figure I-10 (continued). Operating Data For TCA Run 907-2A

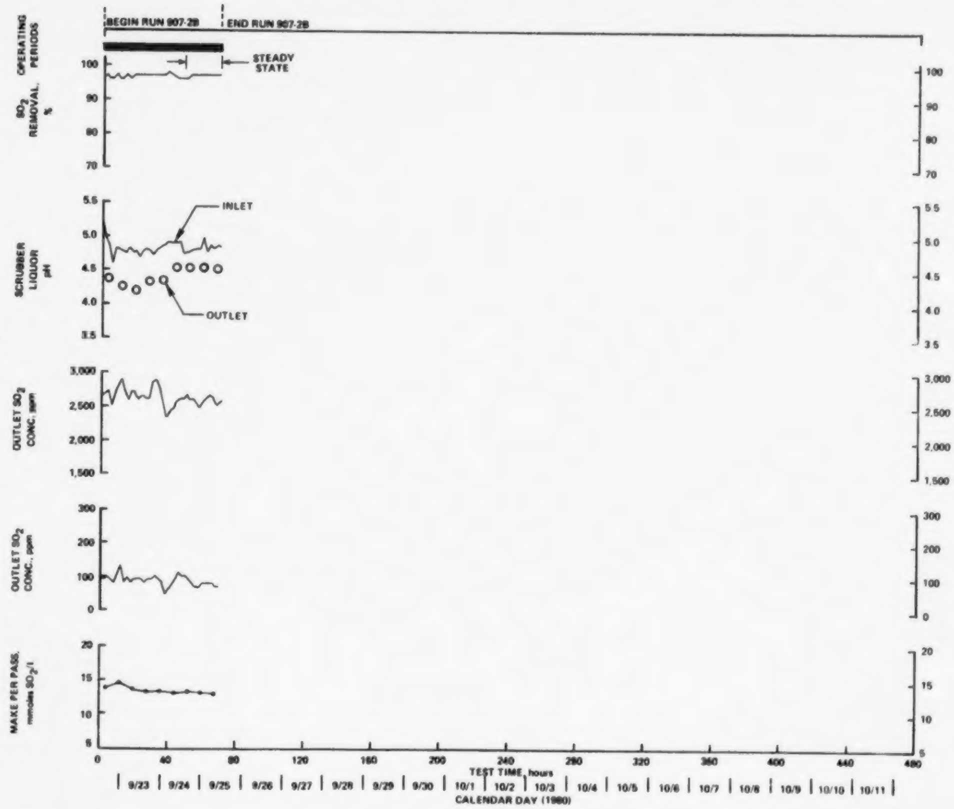
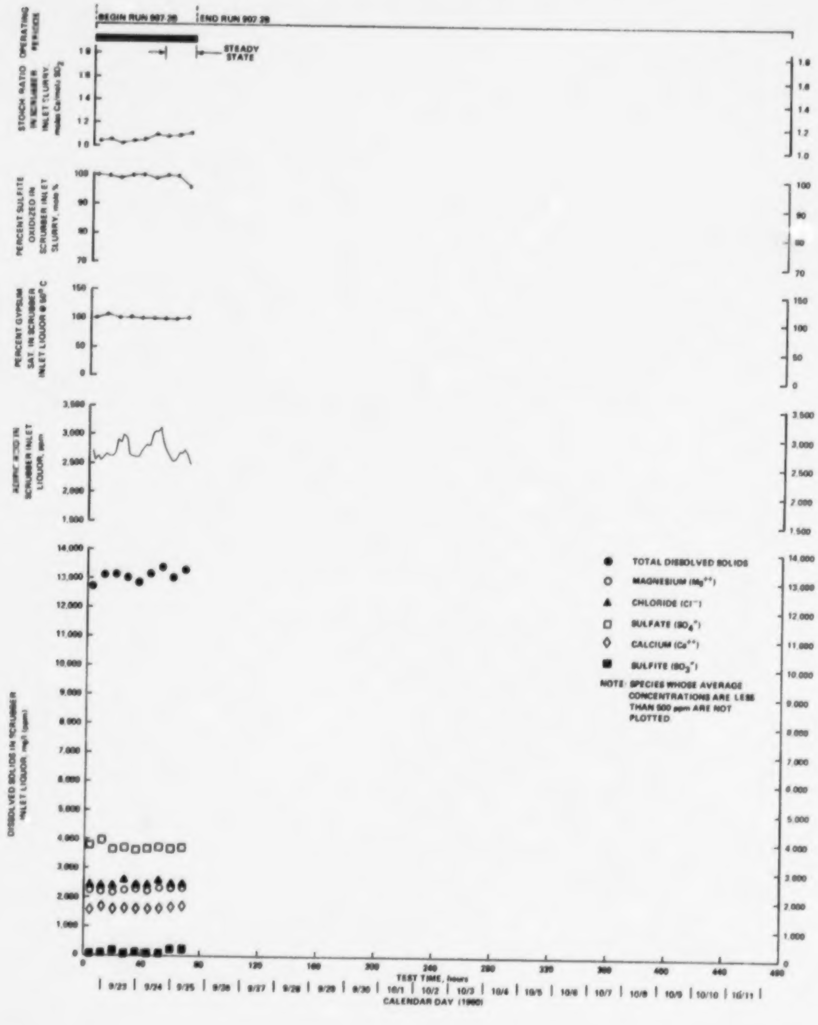


Figure I-11. Operating Data For TCA Run 907-2B



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 29 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.8-10.3 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.2-9.4 in. H_2O
Mist Elim.Pressure Drop = 0.28-0.31 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 89-93 wt %
Clarified Liquor Returned to EHT

Figure I-11 (continued). Operating Data For TCA Run 907-2B

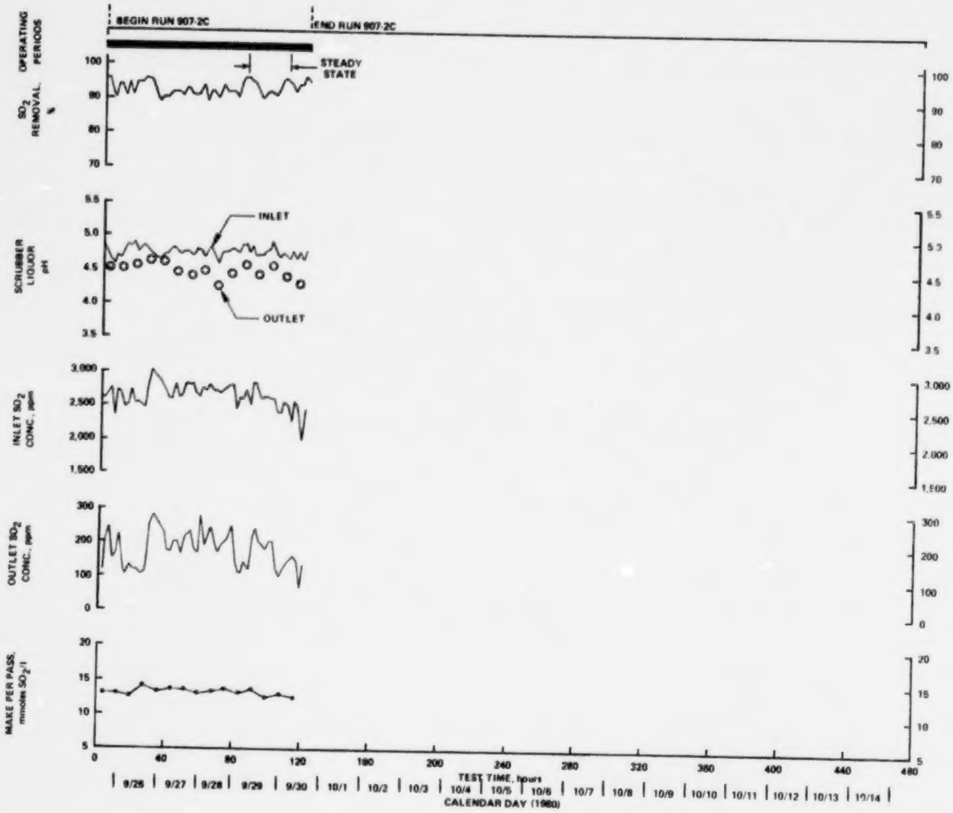
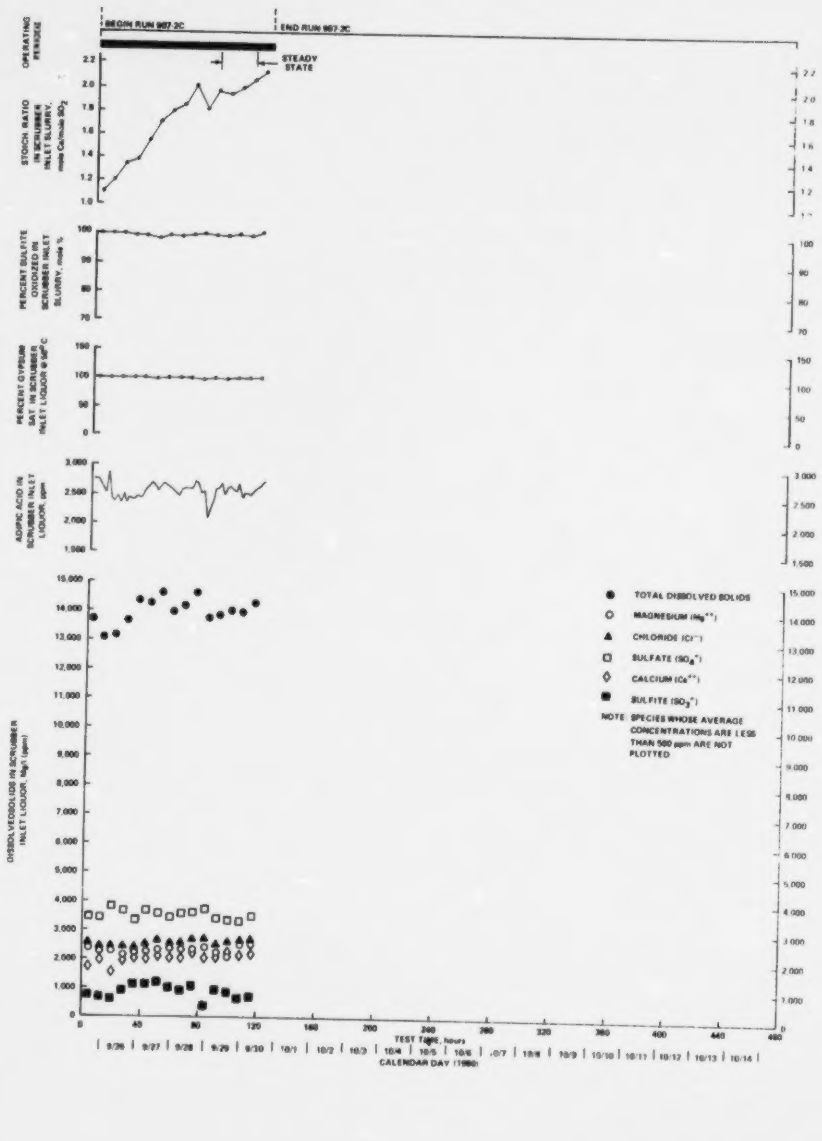


Figure I-12. Operating Data For TCA Run 907-2C



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 22 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.8-10.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.1-8.3 in. H_2O
Mist Elim. Pressure Drop = 0.27-0.32 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 88 wt %
Clarified Liquor Returned to EHT

Figure I-12 (continued). Operating Data For TCA Run 907-2C

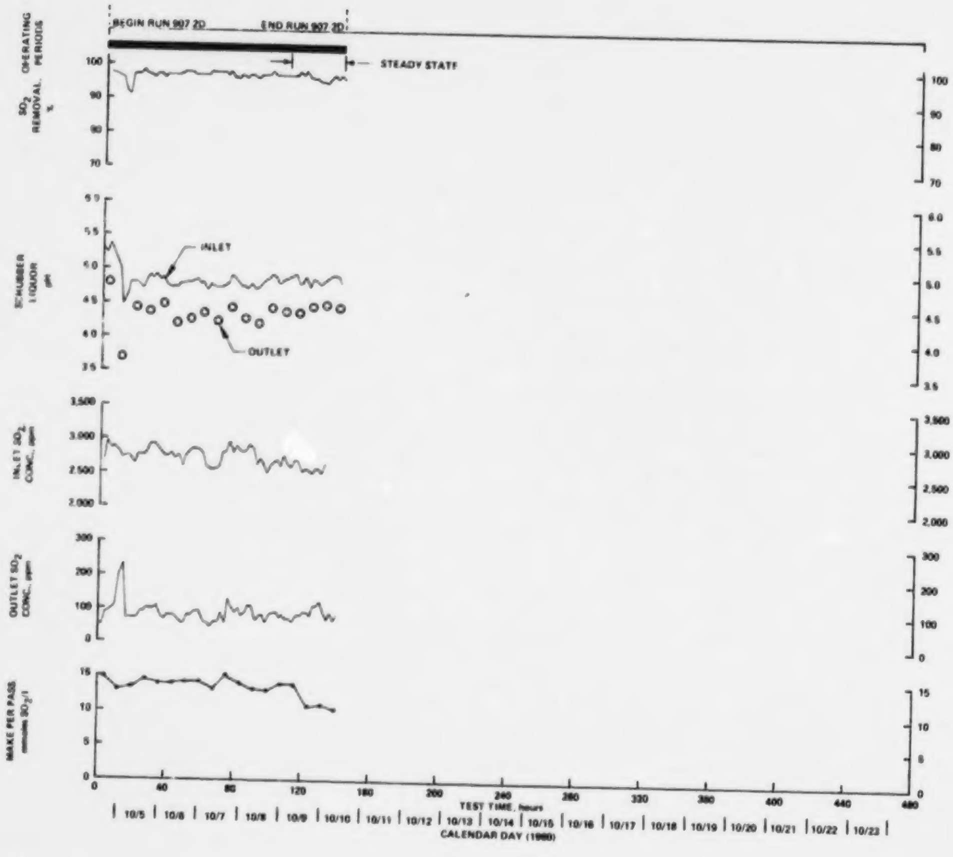
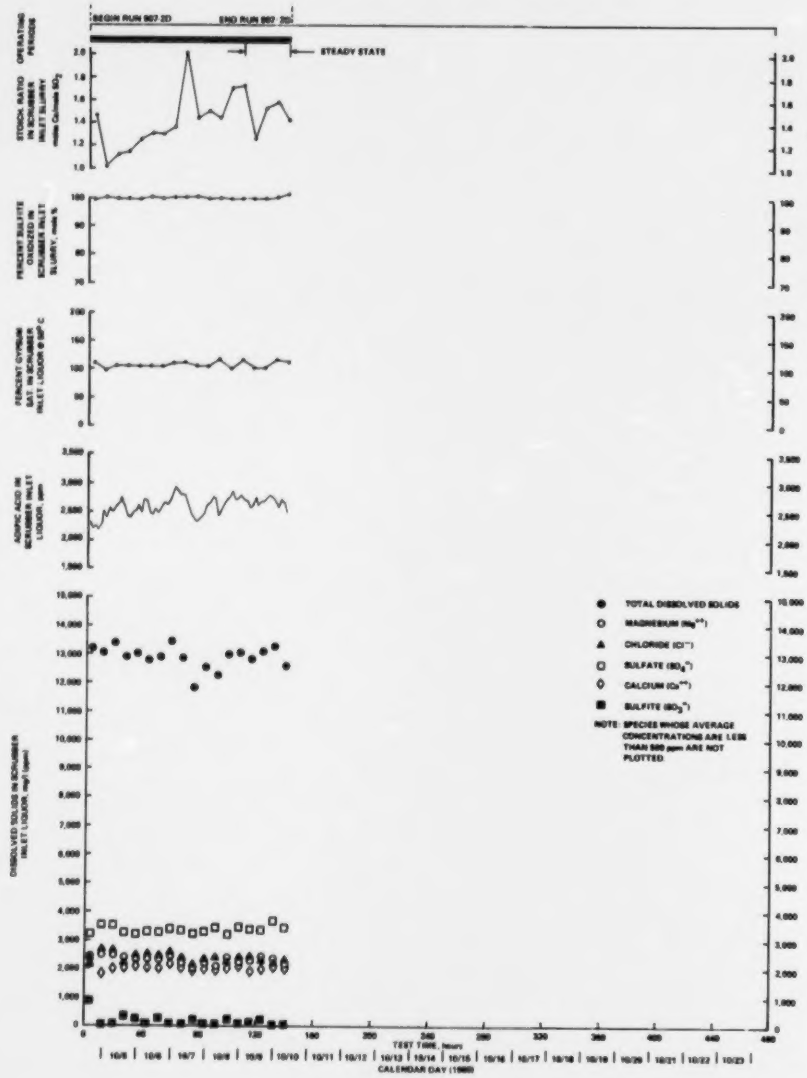


Figure I-13. Operating Data For TCA Run 907-2D



Gas Rate = 30,000 acfm @ 300°F
Scrubber Gas Velocity = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 22 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.9 to 11.0 wt%
Total Pressure Drop, Excluding Mist Elim.
= 7.3 to 8.5 in. H_2O
Mist Elim. Pressure Drop = 0.29 to 0.34 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 81 to 91 wt %
Clarified Liquor Returned to EHT

Figure I-13 (continued). Operating Data For TCA Run 907-2D

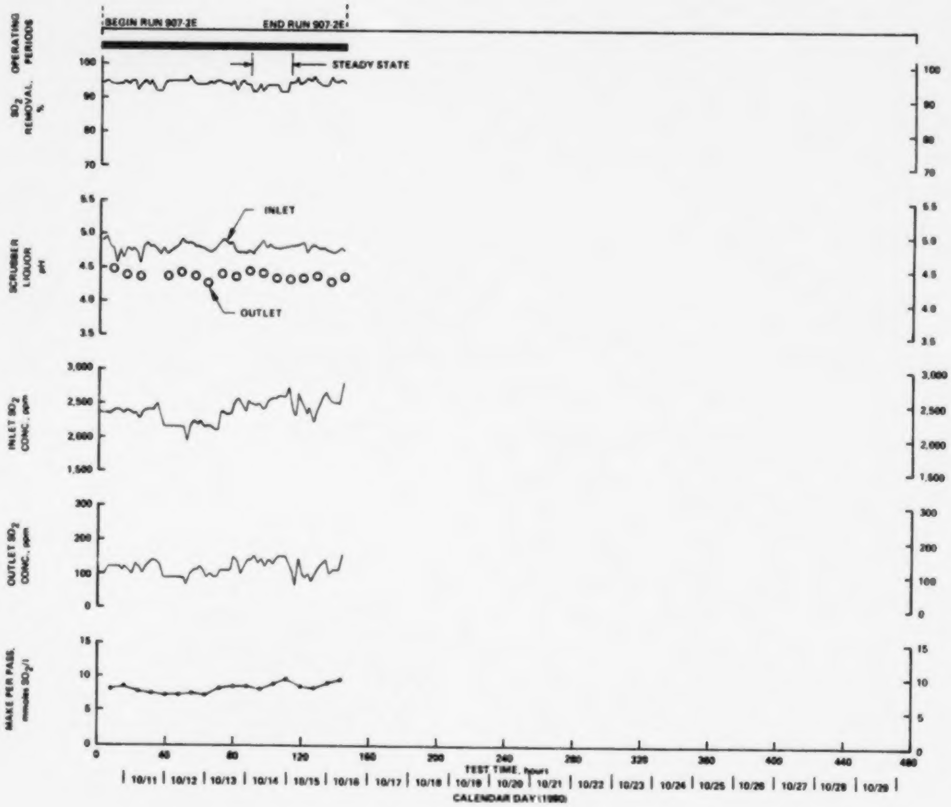
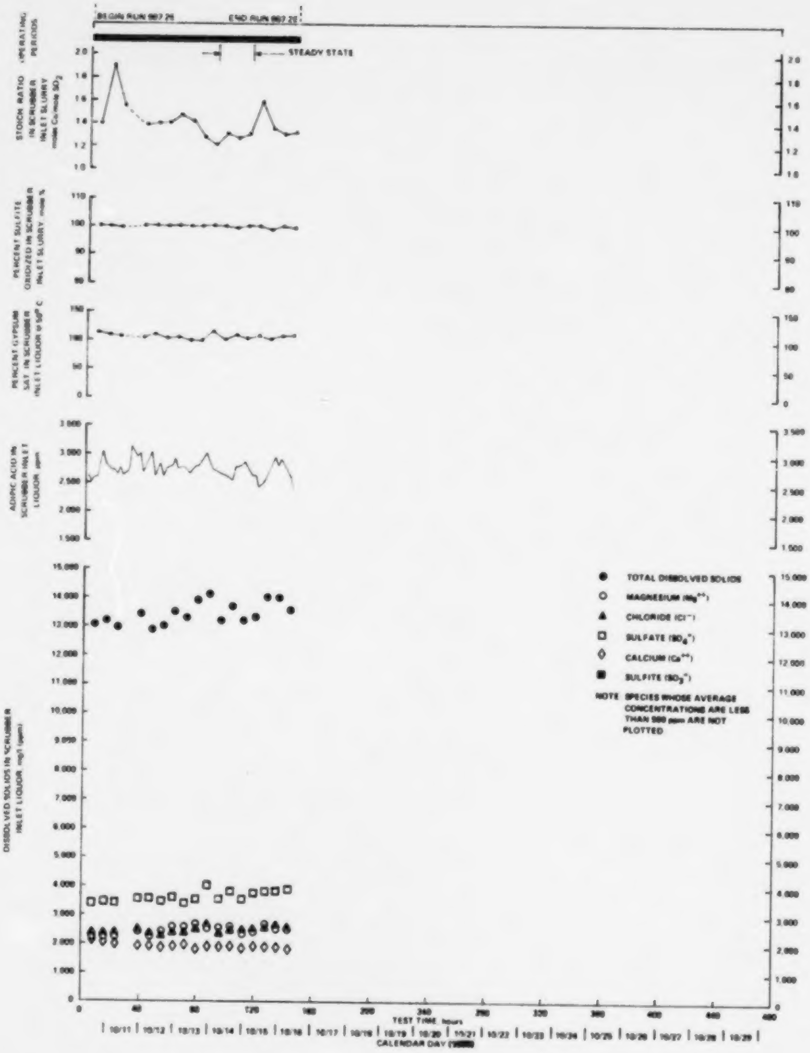


Figure I-14. Operating Data For TCA Run 907-2E



Gas Rate = 25,000 acfm @ 300°F
Scrubber Gas Velocity = 10.4 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 60 gal/Mcf
EHT Residence Time = 22 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.3 to 10.6 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.3 to 6.1 in. H_2O
Mist Elim. Pressure Drop = 0.22 to 0.28 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 89 to 91 wt %
Clarified Liquor Returned to EHT

Figure I-14 (continued). Operating Data For TCA Run 907-2E

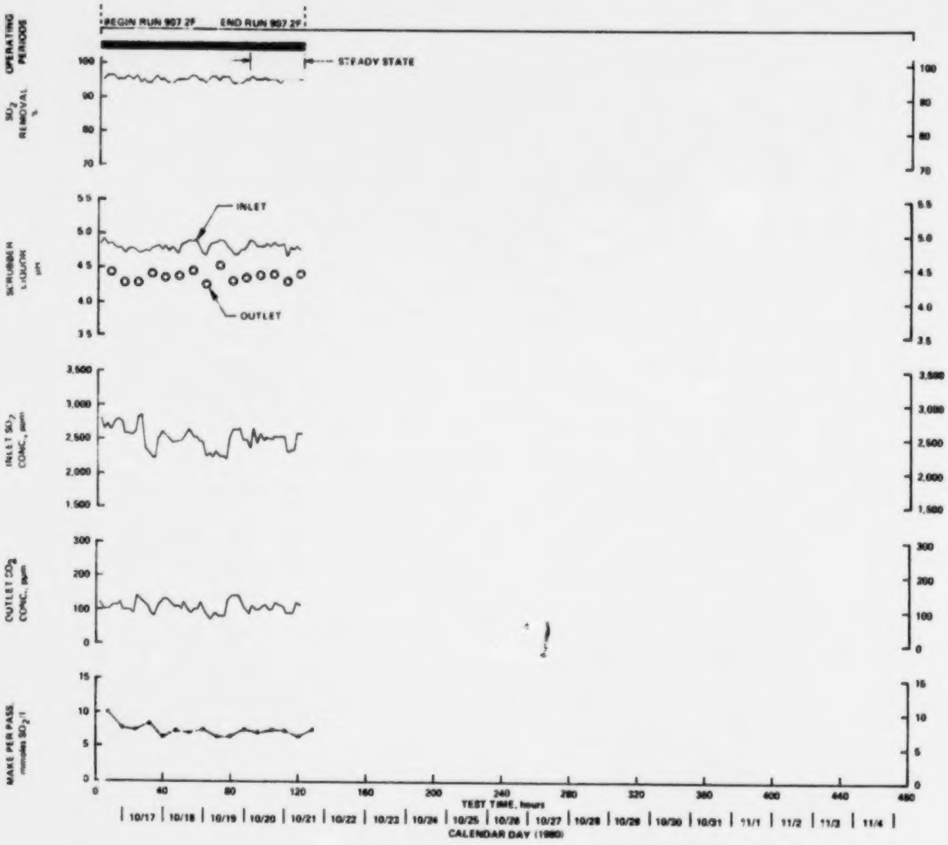
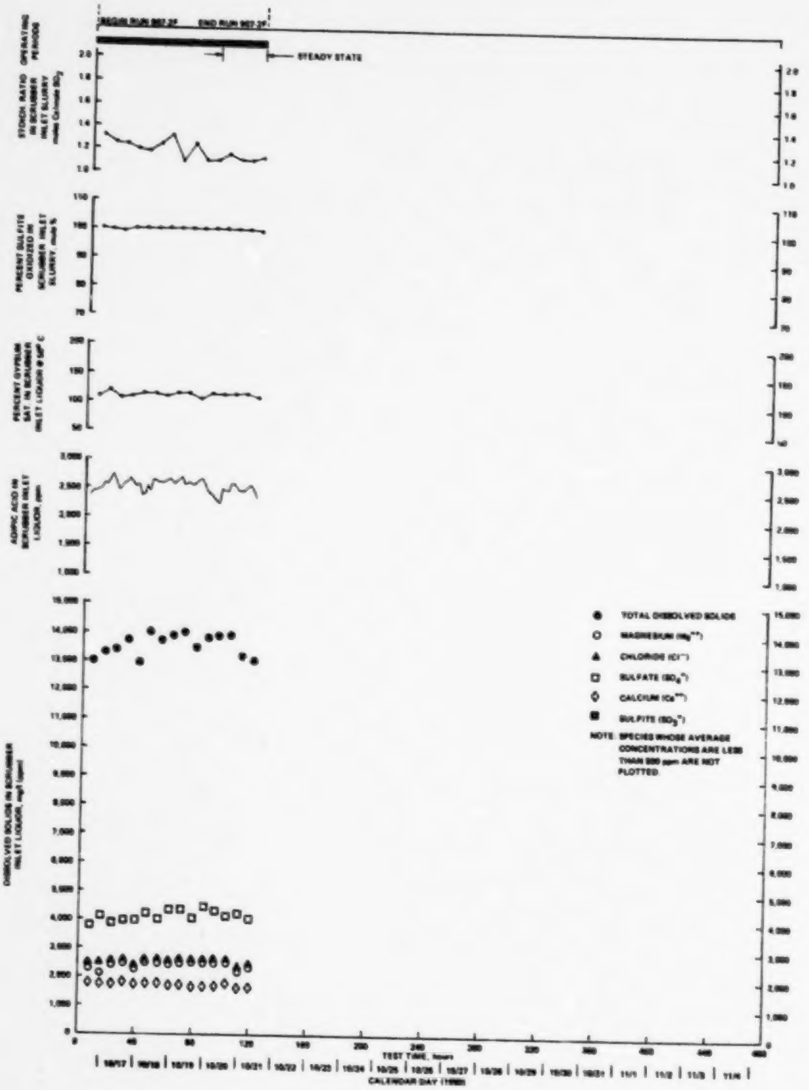


Figure I-15. Operating Data For TCA Run 907-2F



Gas Rate = 20,000 acfm @ 300°F
Scrubber Gas Velocity = 8.3 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 75 gal/Mcf
EHT Residence Time = 22 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.6 to 10.0 wt %
Total Pressure Drop, Excluding Mist Elim.
= 4.3 to 4.8 in. H_2O
Mist Elim. Pressure Drop = 0.14 to 0.19 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 84 to 93 wt %
Clarified Liquor Returned to EHT

Figure I-15 (continued). Operating Data For TCA Run 907-2F

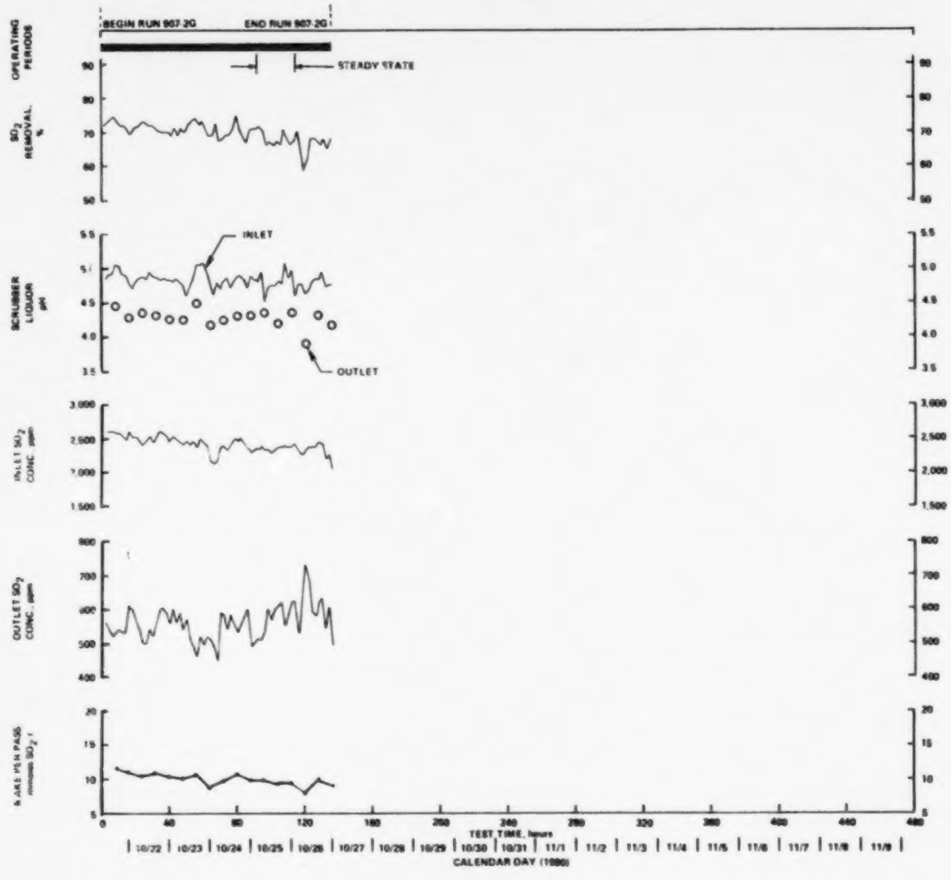
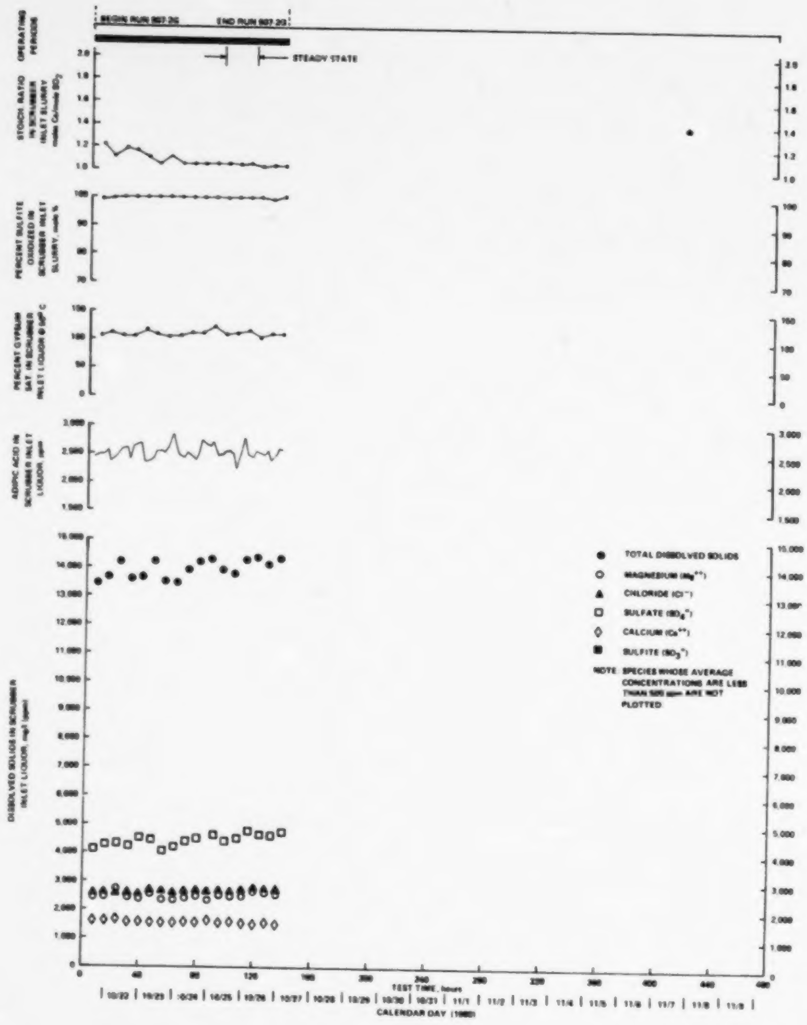


Figure I-16. Operating Data For TCA Run 907-2G



Gas Rate = 20,000 acfm @ 300°F
Scrubber Gas Velocity = 8.3 ft/sec @ 125°F
Liquor Rate = 600 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 43 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.9 to 10.0 wt %
Total Pressure Drop, Excluding Mist Elim.
= 3.1 to 3.4 in. H_2O
Mist Elim. Pressure Drop = 0.12 to 0.16 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 90 to 94 wt %
Clarified Liquor Returned to EHT

Figure I-16 (continued). Operating Data For TCA Run 907-2G

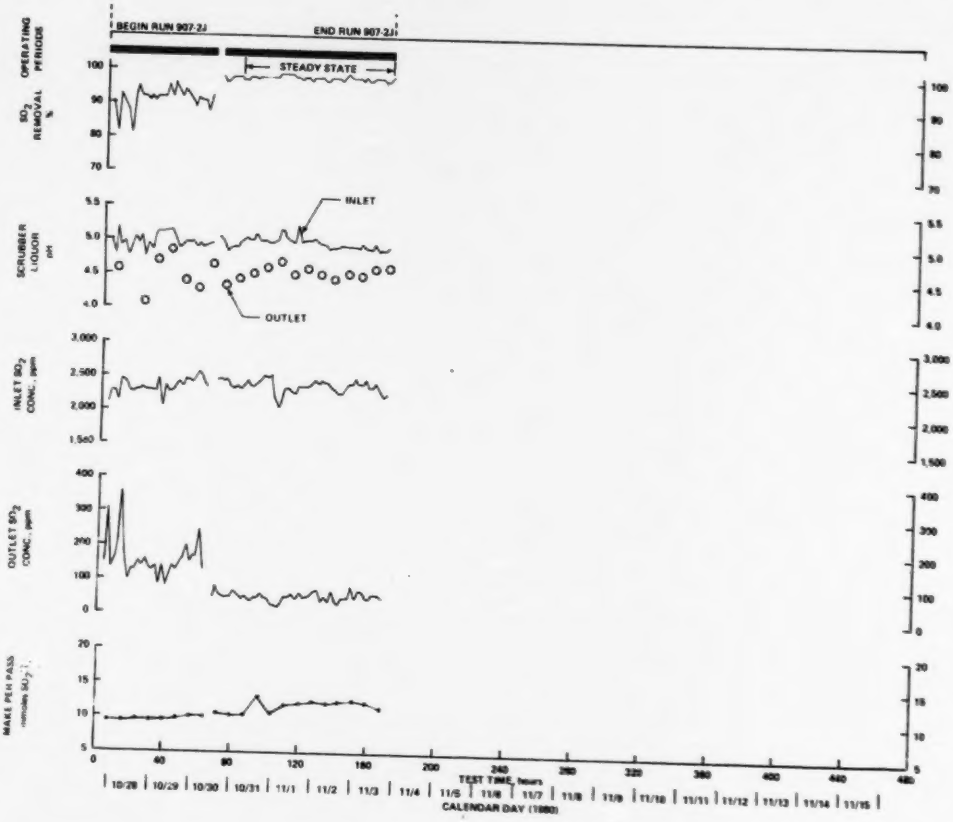
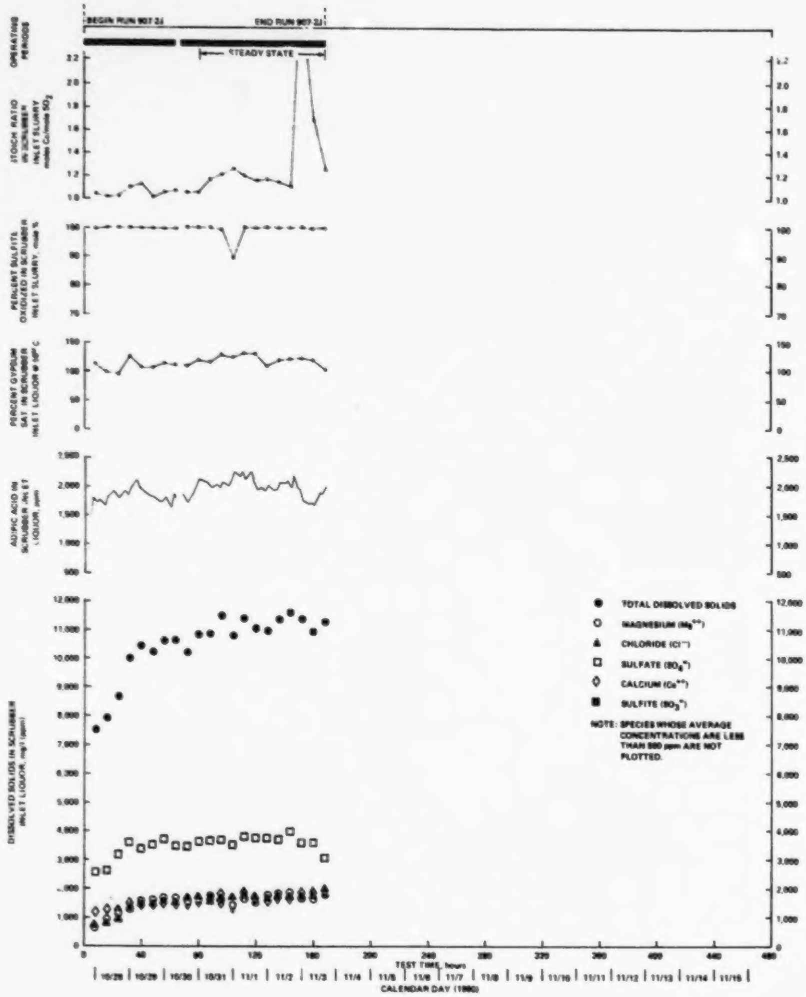


Figure I-17. Operating Data For TCA Run 907-2J



Gas Rate = 30,000 acfm @ 300°F
Scrubber Gas Velocity = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 29 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 5.1 to 11.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.8 to 13.5 in. H_2O
Mist Elim. Pressure Drop = 0.20 to 0.32 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 90 to 98 wt %
Clarified Liquor Returned to EHT

Figure I-17 (continued). Operating Data For TCA Run 907-2J

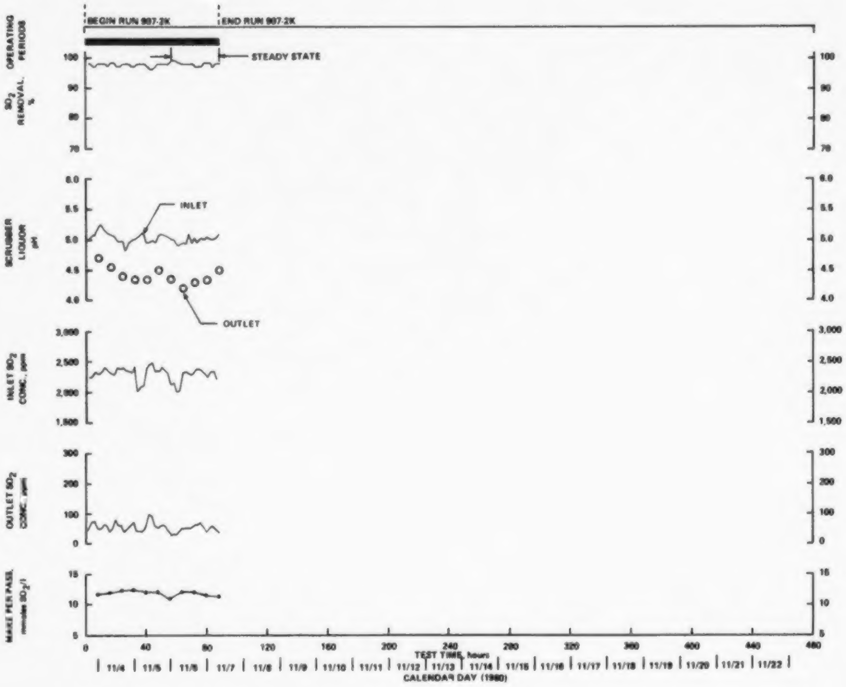
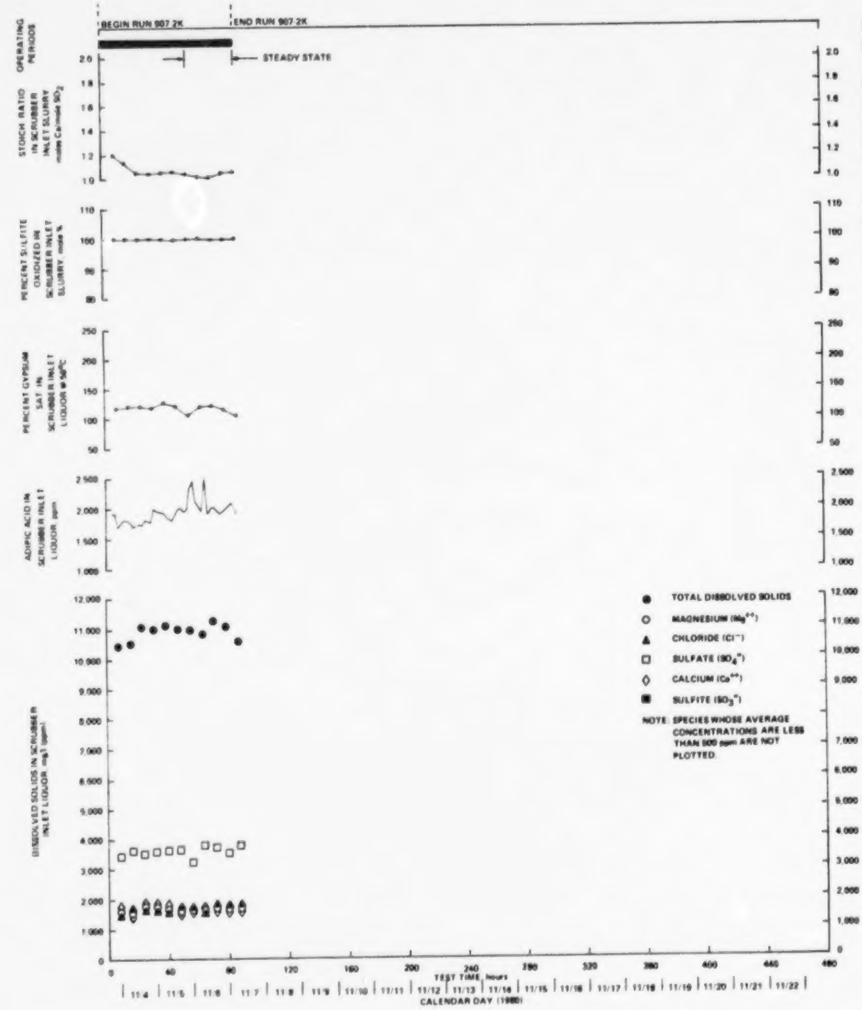


Figure I-18. Operating Data For TCA Run 907-2K



Gas Rate = 30,000 acfm @ 300°F
Scrubber Gas Velocity = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 35 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.4 to 10.3 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.7 to 11.1 in. H_2O
Mist Elim. Pressure Drop = 0.25 to 0.31 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 86 to 94 wt %
Clarified Liquor Returned to EHT

Figure I-18 (continued). Operating Data For TCA Run 907-2K

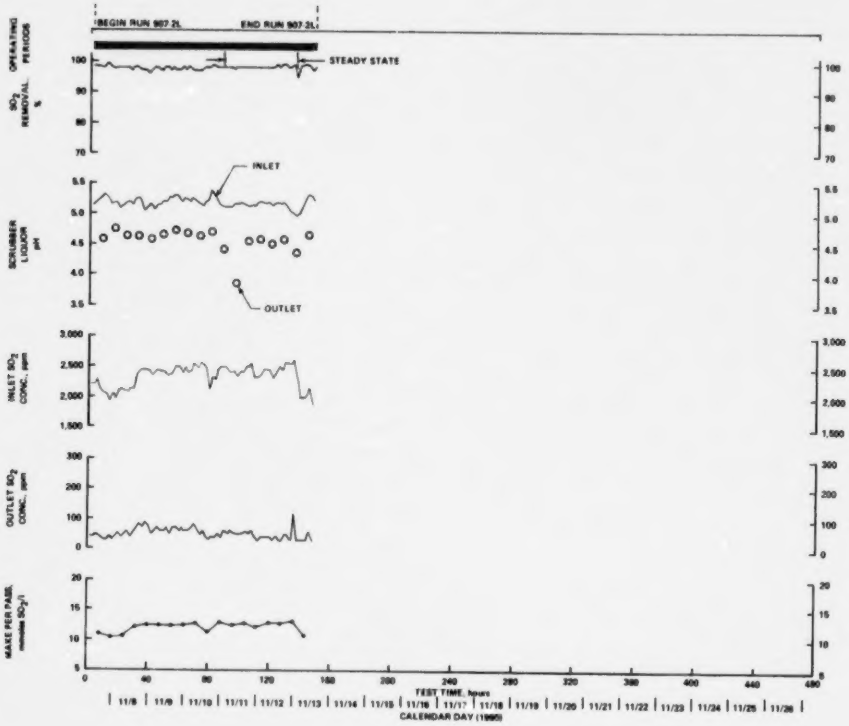
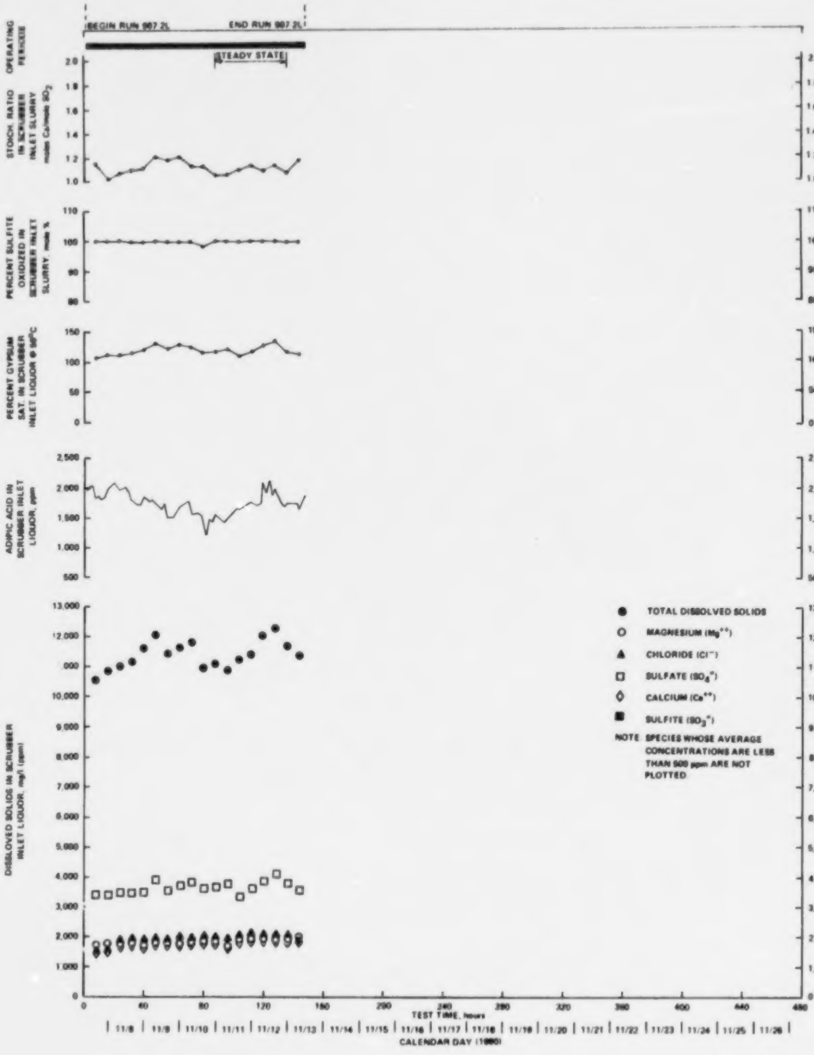


Figure I-19. Operating Data For TCA Run 907-2L



Gas Rate = 30,000 acfm @ 300°F
Scrubber Gas Velocity = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 35 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.5 to 10.0 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.7 to 17.0 in. H_2O
Mist Elim. Pressure Drop = 0.22 to 0.30 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 83 to 92 wt %
Clarified Liquor Returned to EHT

Figure I-19 (continued). Operating Data For TCA Run 907-2L

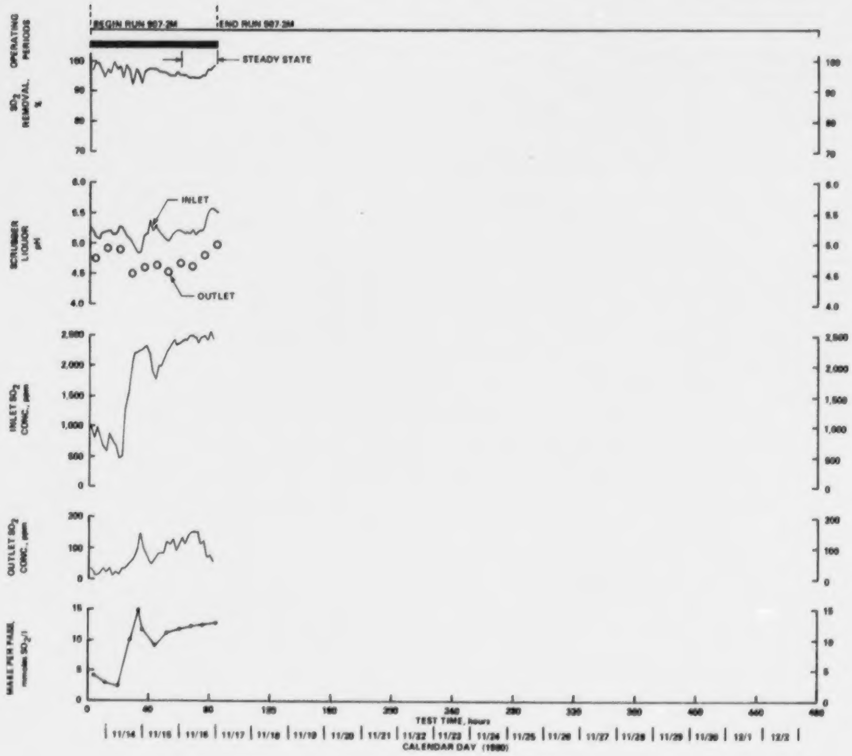
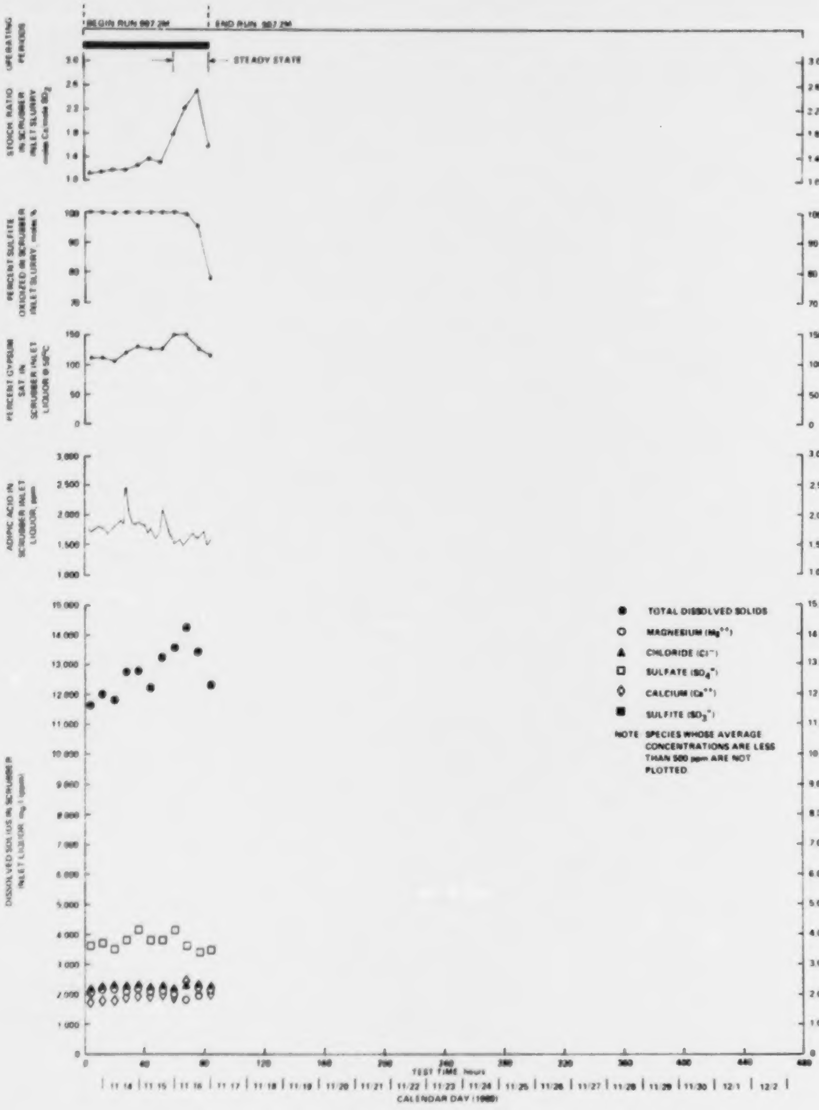
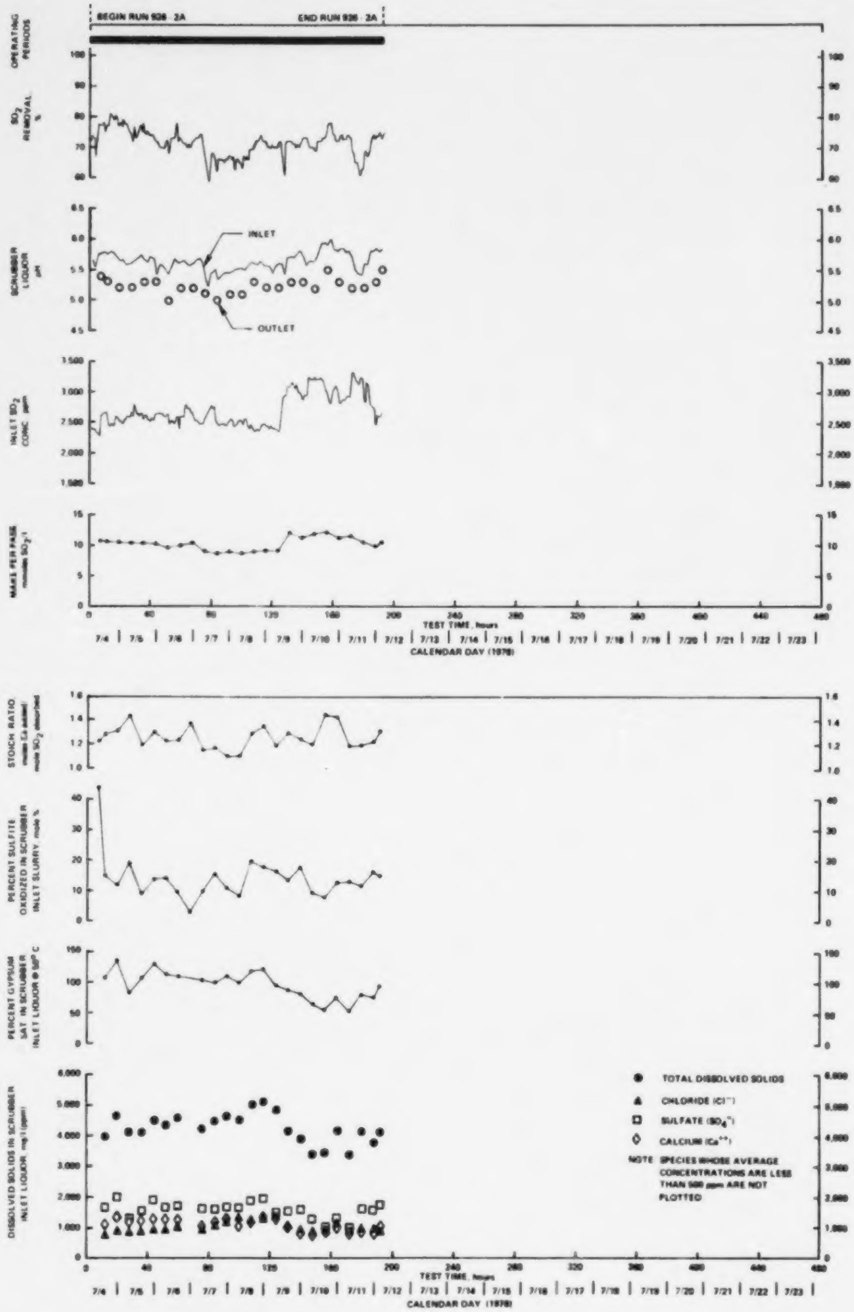


Figure I-20. Operating Data For TCA Run 907-2M



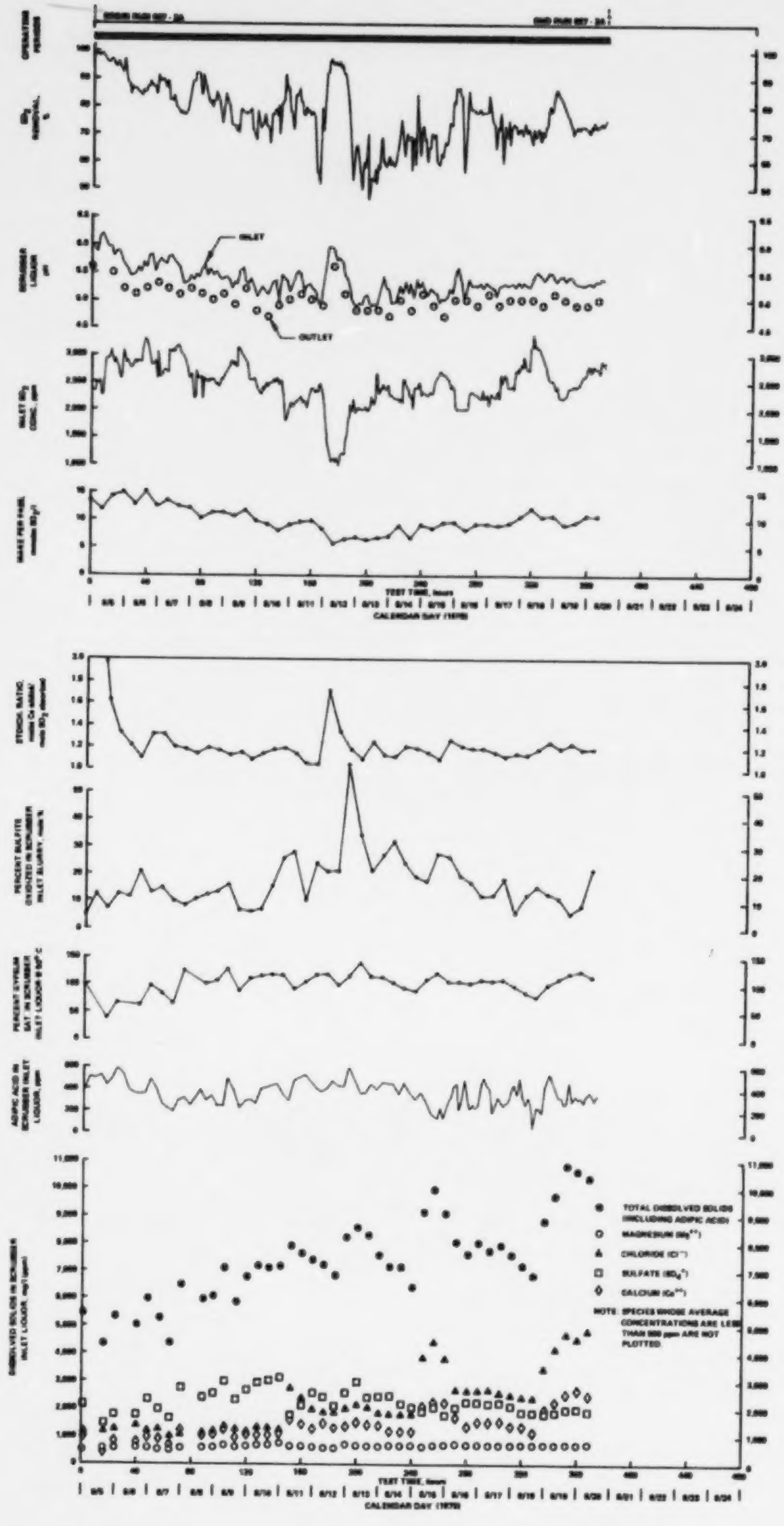
Gas Rate = 30,000 acfm @ 300°F
Scrubber Gas Velocty = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/mcf
EHT Residence Time = 29 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.3 to 10.3 wt %
Total Pressure Drop, Excluding Mist Elim. = 8.2 to 11.3 in. H_2O
Mist Elim. Pressure Drop = 0.24 to 0.27 in. H_2O
Discharge (Clarifier & Belt Filter) Solids Concentration = 79 to 80 wt %
Clarified Liquor Returned to EHT

Figure I-20 (continued). Operating Data For TCA Run 907-2M



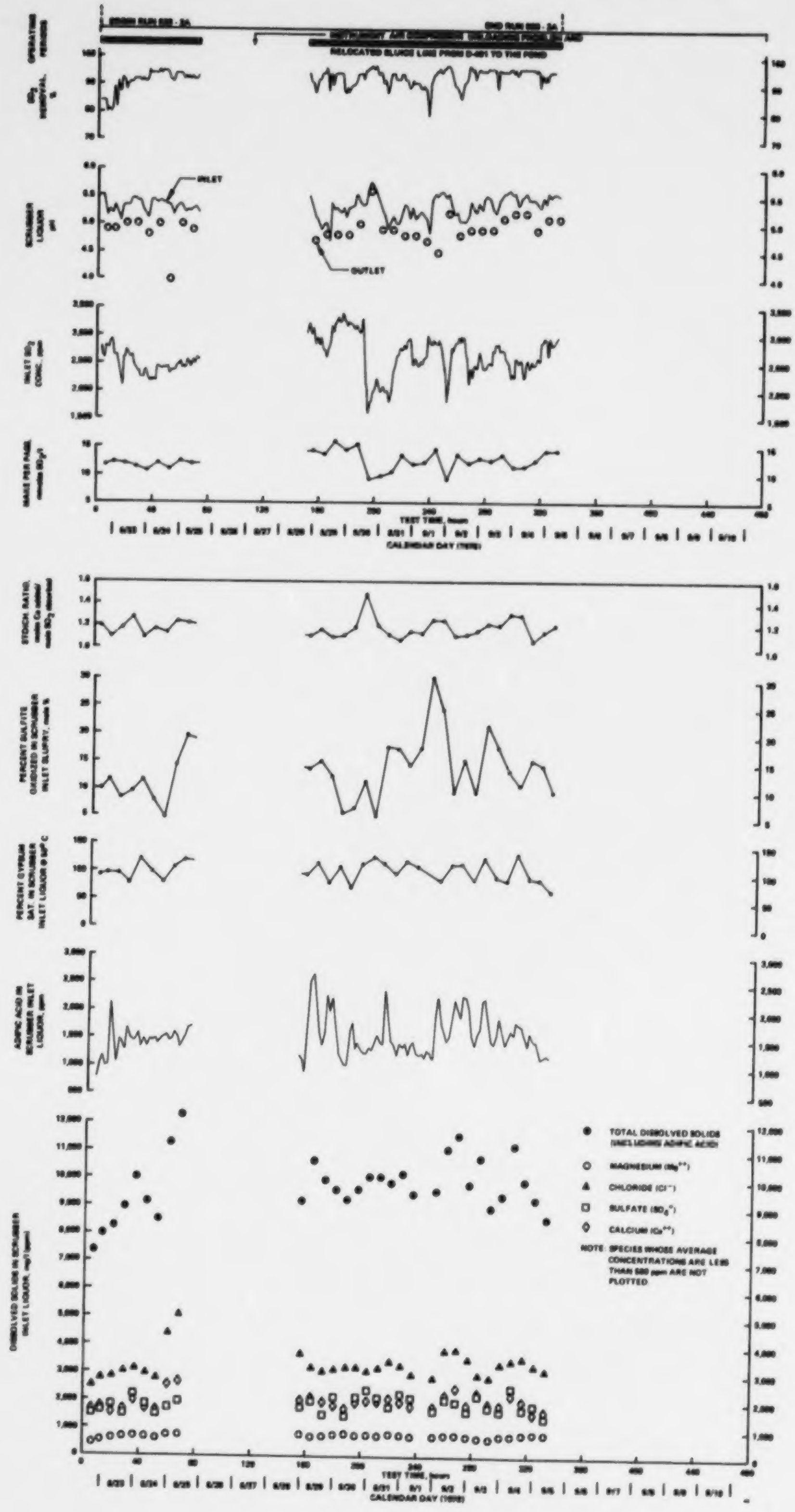
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.7 - 16.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.7 - 8.6 in. H_2O
Mist Elim. Pressure Drop = 0.53 - 0.62 in. H_2O
Discharge (Clarifier) Solids
Concentration = 31 - 43 wt %
Limestone Addition to EHT

Figure I-21. Operating Data For TCA Run 926-2A



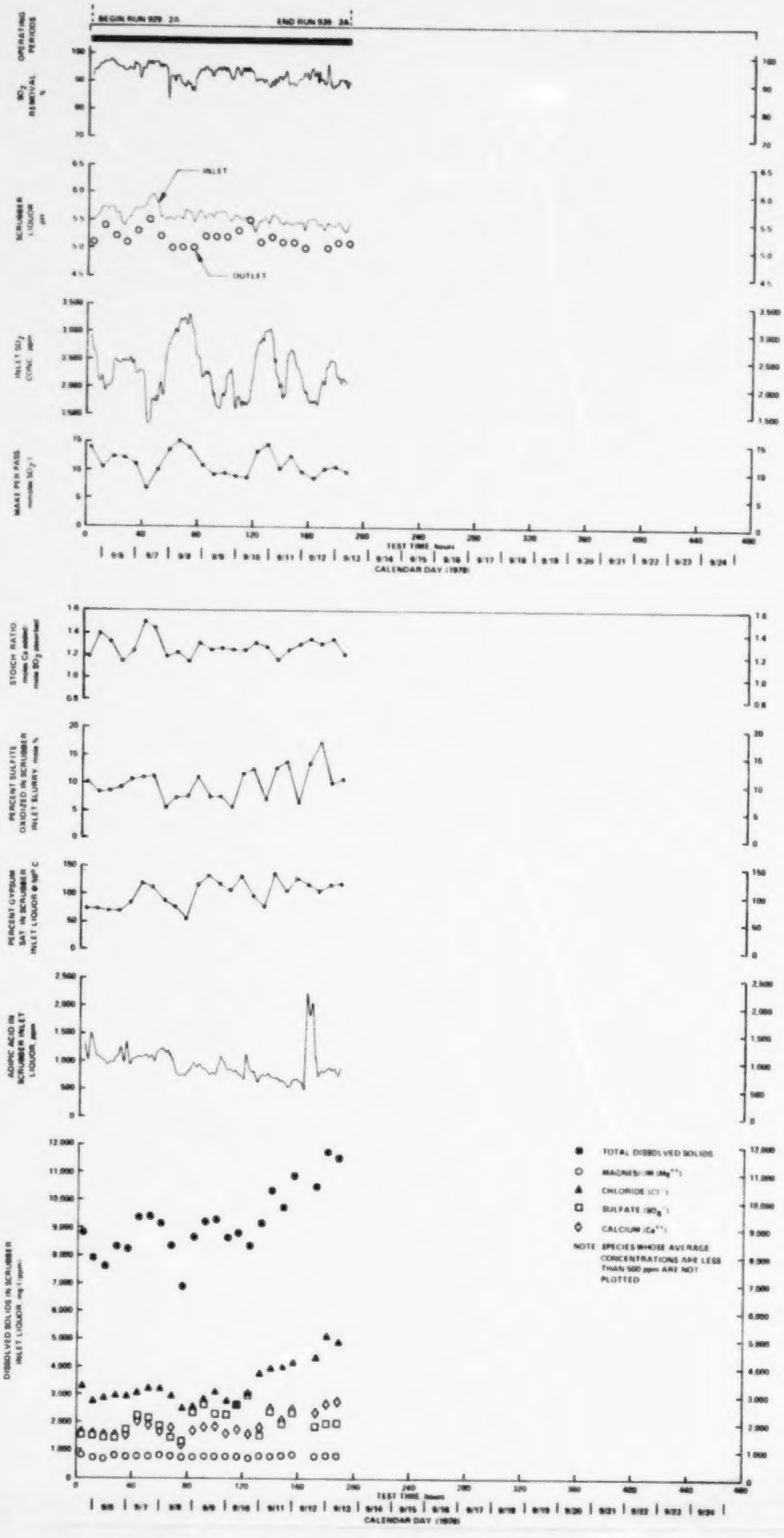
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. Spheres/bed
Percent Solids Recirculated = 13.7 - 15.5 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.5 - 7.4 in. H_2O
Mist Elim. Pressure Drop = 0.52 - 0.60 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 56 - 68 wt %
Limestone and Dry Adipic Acid Addition to EHT

Figure I-22. Operating Data For TCA Run 927-2A



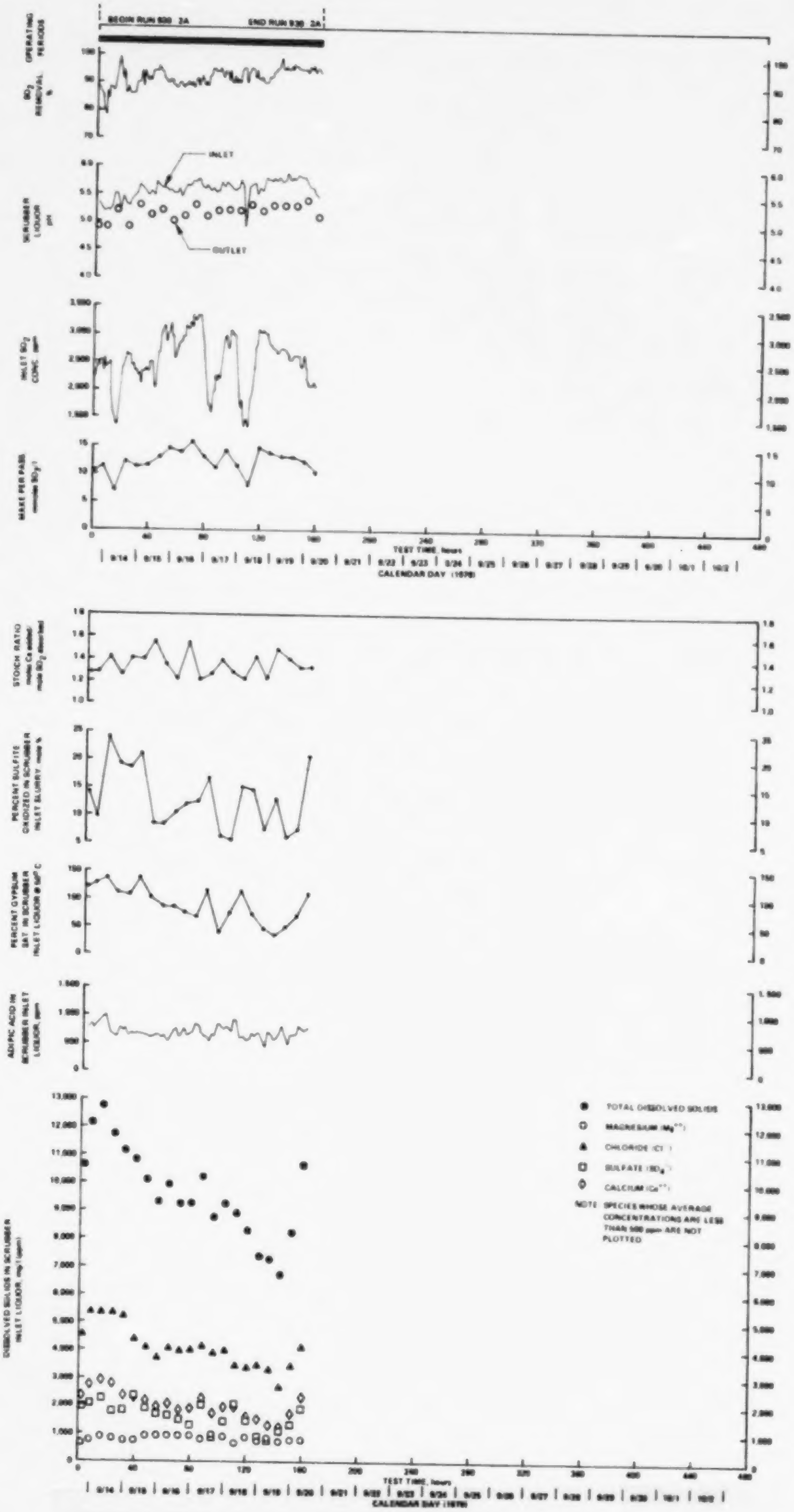
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.3 - 16.6 wt %
Total Pressure Drop, Excluding Mist Elim.
. = 6.3 - 7.0 in. H_2O
Mist Elim. Pressure Drop = 0.48 - 0.63 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 56 - 62 wt %
Limestone and Dry Adipic Acid Addition to EHT

Figure I-23. Operating Data For TCA Run 928-2A



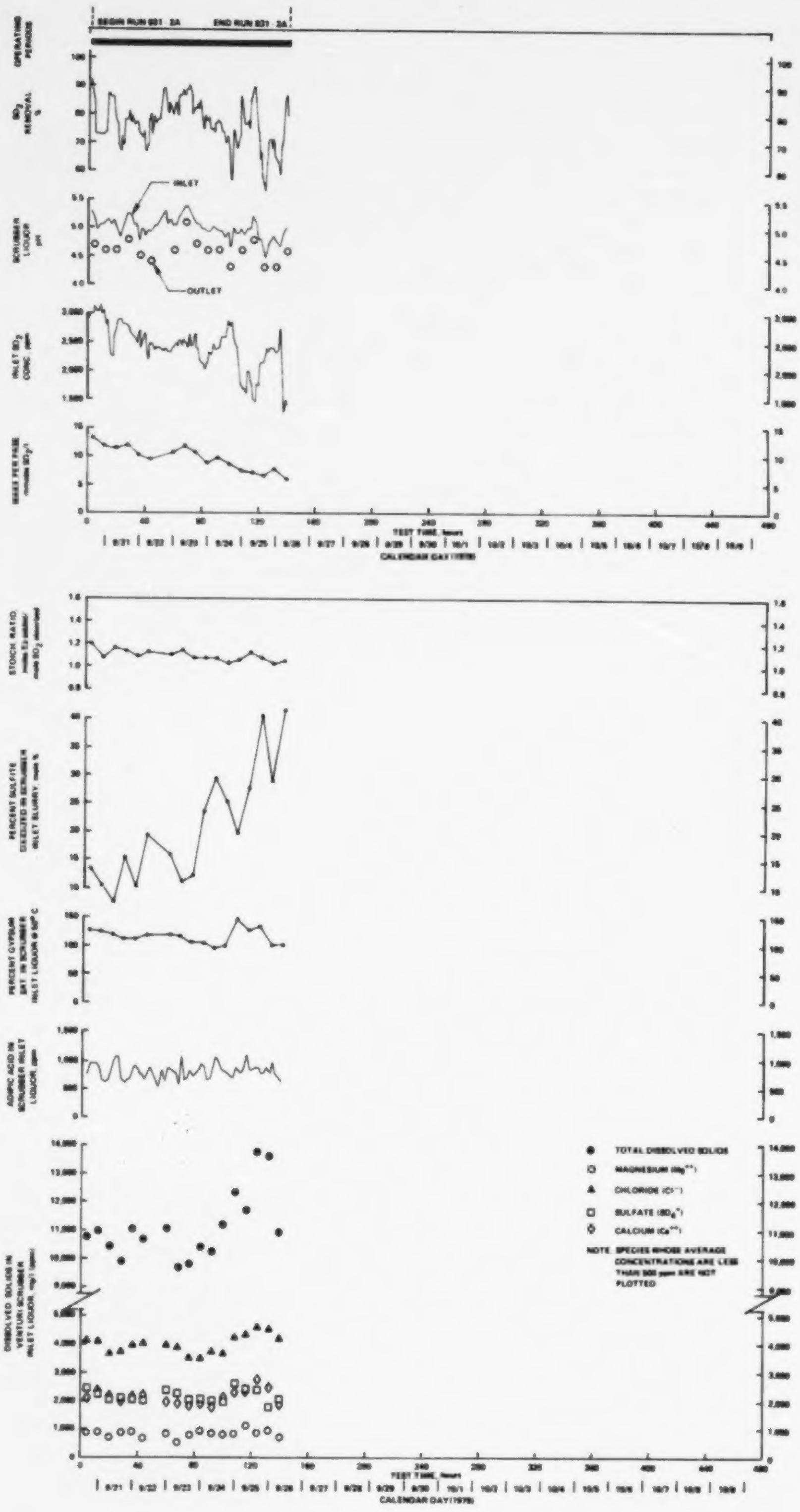
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4 . 1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.6 - 15.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.1 - 7.1 in. H_2O
Mist Elim. Pressure Drop = 0.49 - 0.56 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 56 - 62 wt %
Limestone & Dry Adipic Acid Addition to EHT

Figure I-24. Operating Data For TCA Run 929-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.3 - 15.7 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.2 - 7.1 in. H_2O
Mist Elim. Pressure Drop = 0.50 - 0.63 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 54 - 62 wt %
Limestone & Dry Adipic Acid Addition to EHT

Figure I-25. Operating Data For TCA Run 930-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.0 - 14.8 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.3 - 7.3 in H_2O
Mist Elim. Pressure Drop = 0.52 - 0.59 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 56 - 68 wt %
Limestone & Dry Adipic Acid Addition to EHT

Figure I-26. Operating Data For TCA Run 931-2A

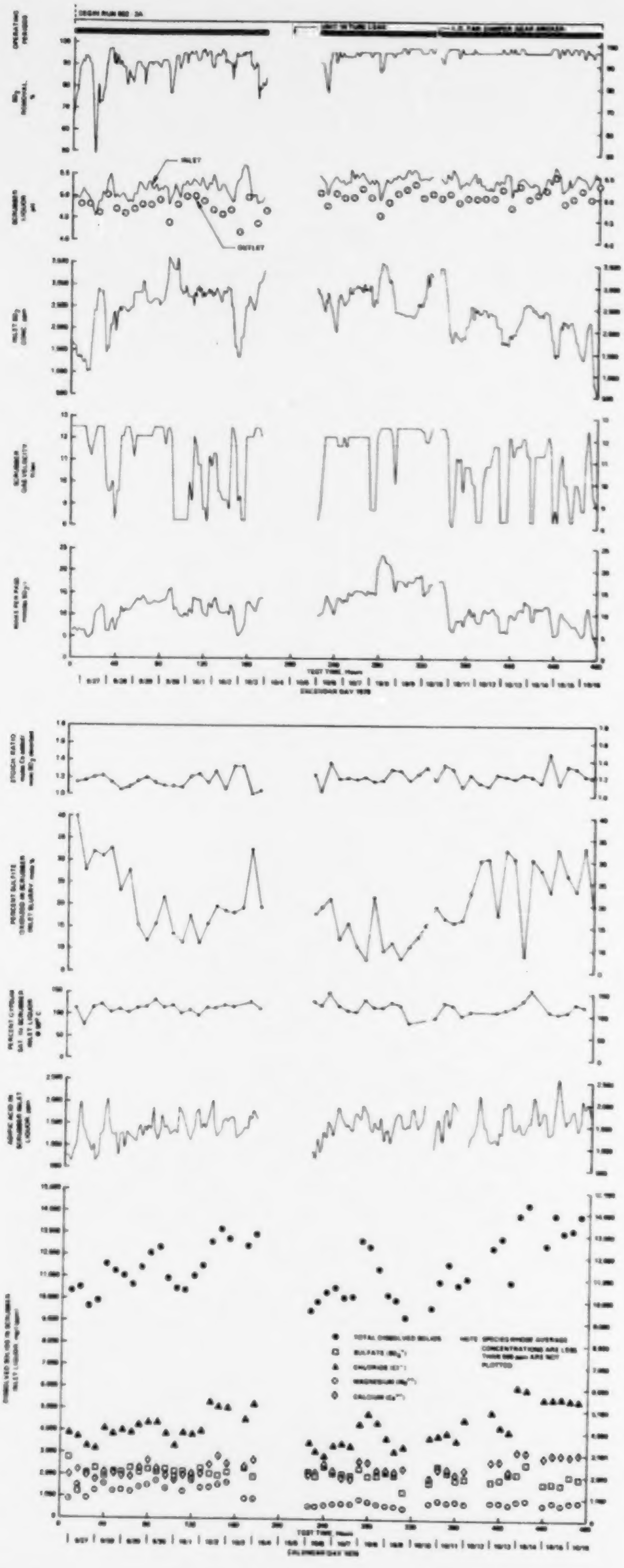
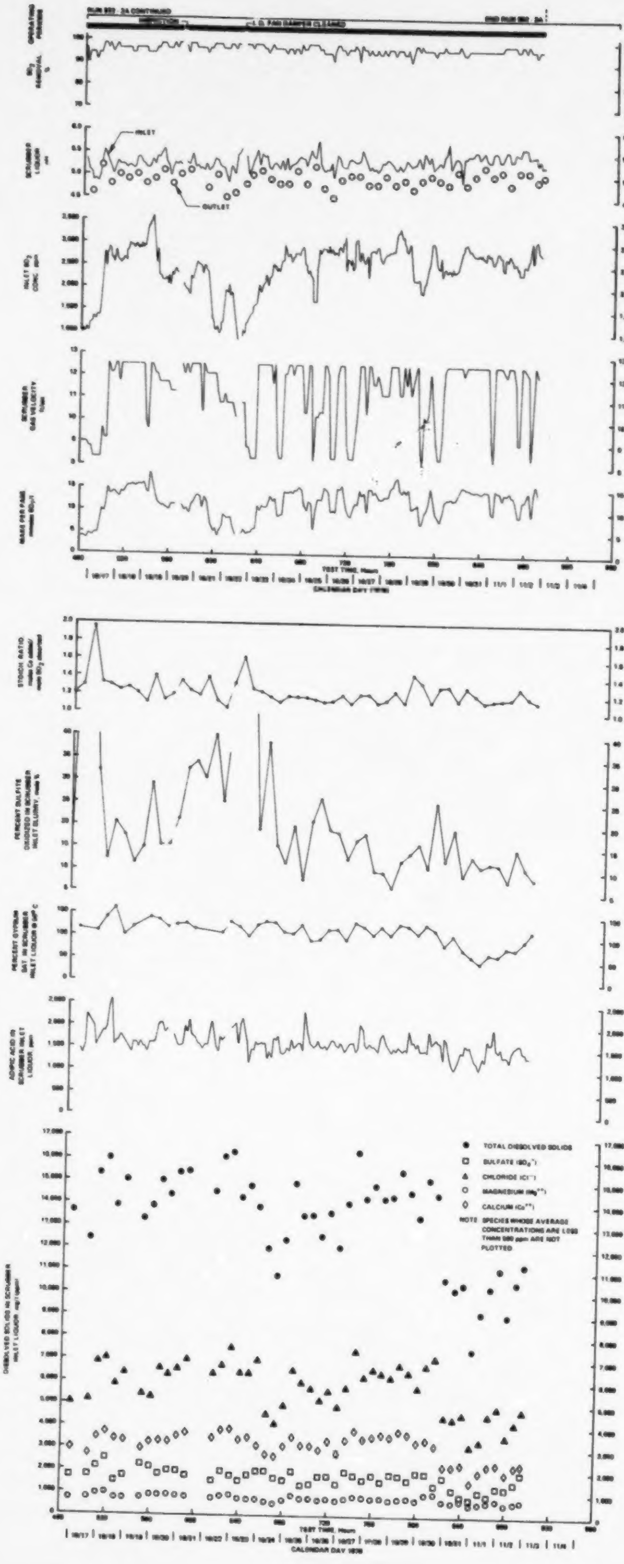
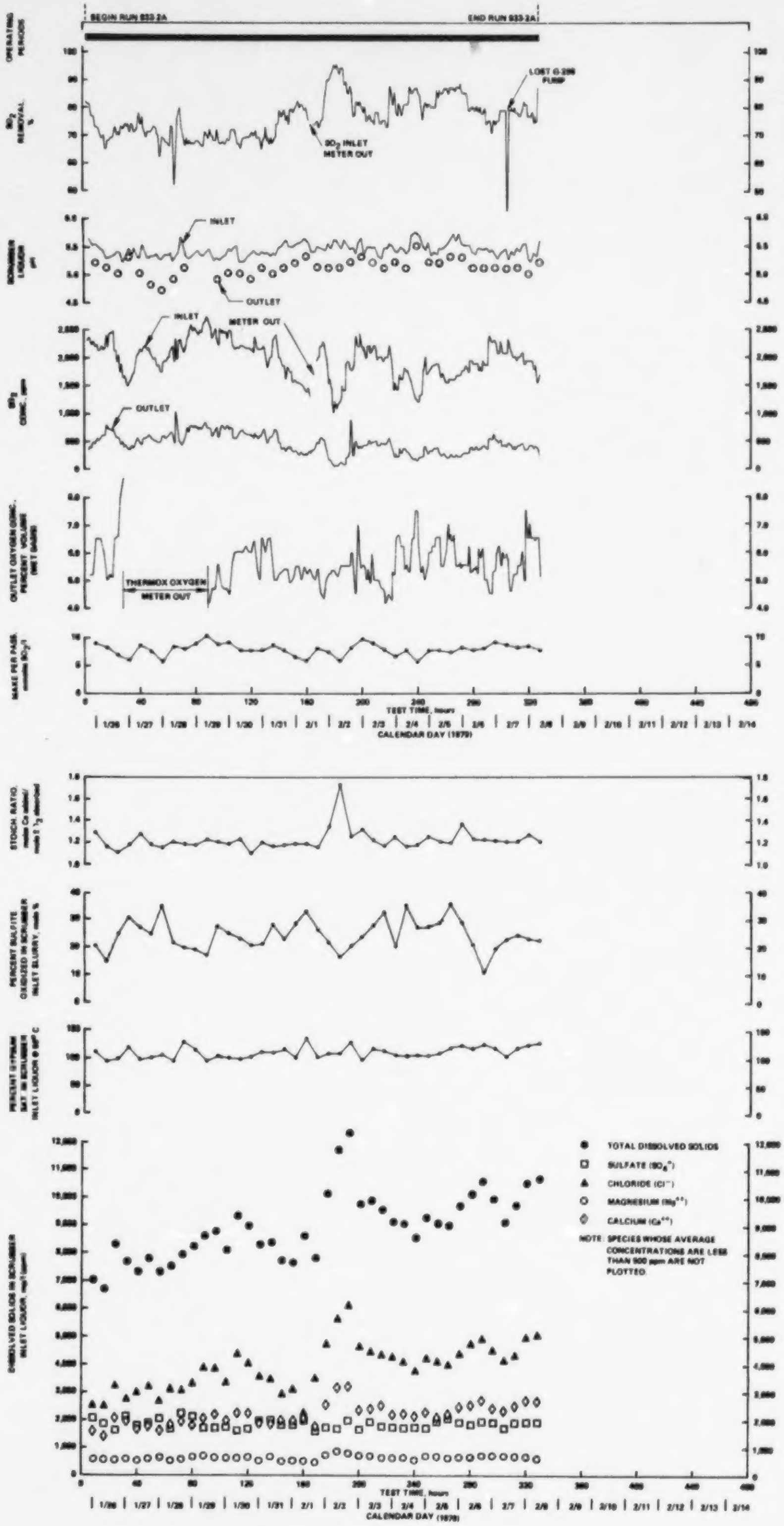


Figure I-27. Operating Data For TCA Run 932-2A



Gas Rate = 20,000 - 30,000 acfm @ 300° F
Gas Velocity = 8.4 - 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 - 75 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 13.7 - 15.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.2 - 9.2 in. H_2O
Mist Elim. Pressure Drop = 0.19 - 0.65 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 57 - 66 wt %
Limestone & Dry Adipic Addition to EHT

Figure I-27 (continued). Operating Data For TCA Run 932-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 12.6 - 15.3 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.8 - 9.1 in. H_2O
Mist Elim. Pressure Drop = 0.44 - 0.58 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 57 wt %
Limestone Addition to EHT

Figure I-28. Operating Data For TCA Run 933-2A

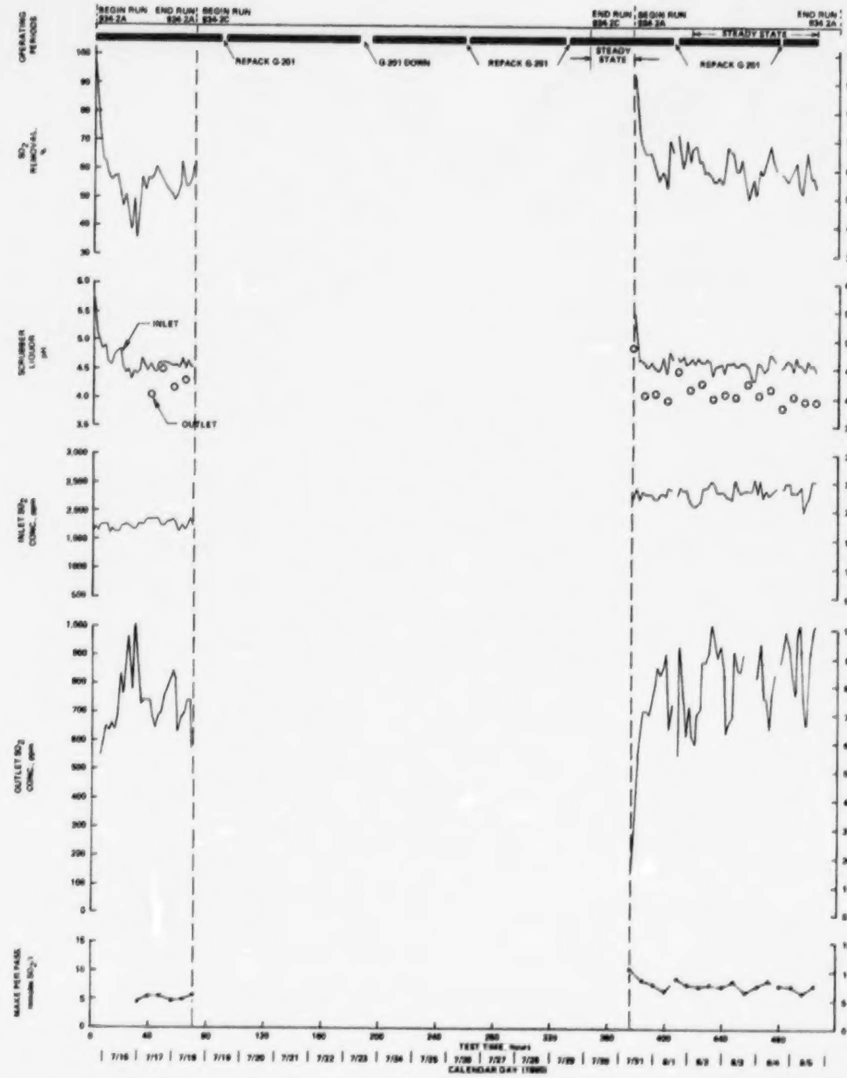
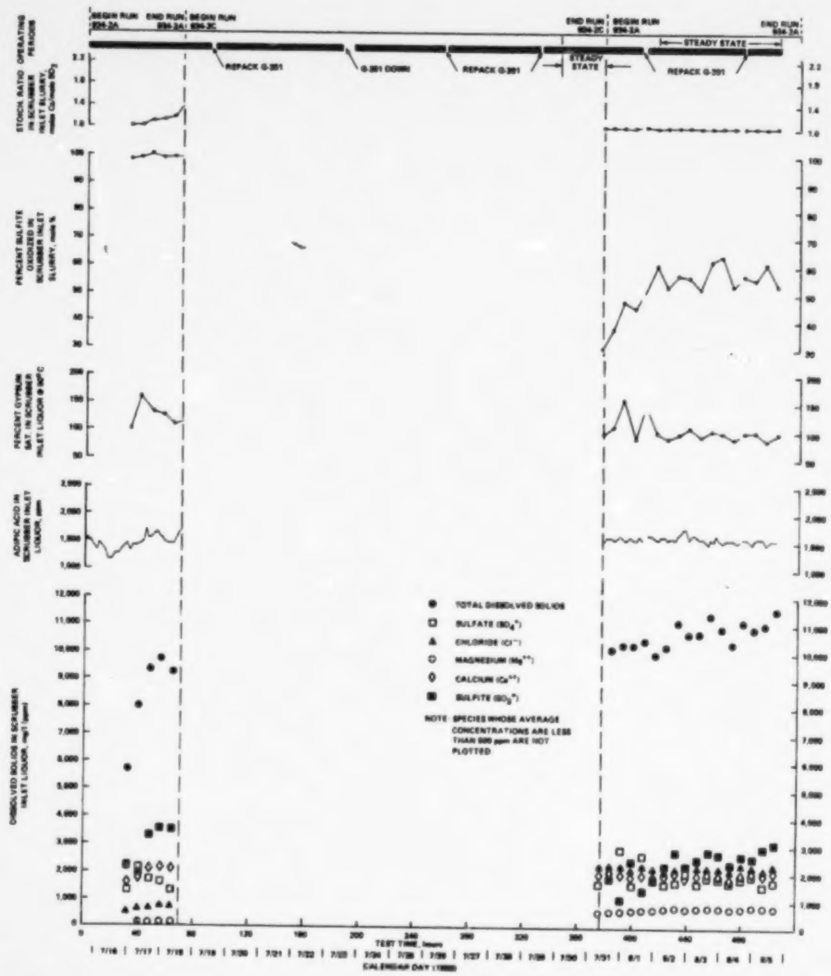


Figure I-29. Operating Data For TCA Run 934-2A



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 37.2 min
Adipic Acid Dry Fed to EHT
Limestone Addition to EHT
Solids Recirculated = 9.2-10.8 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.0-8.4 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.32 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 87-88 wt %
Clarified Liquid Returned to EHT

Figure I-29 (continued). Operating Data For TCA Run 934-2A

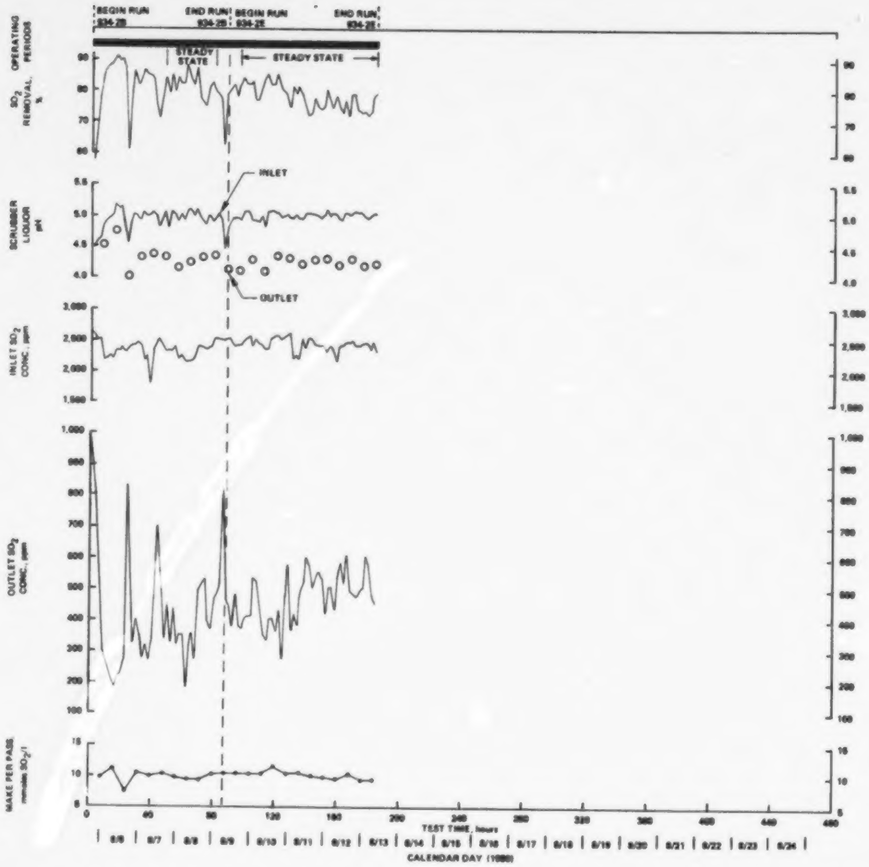
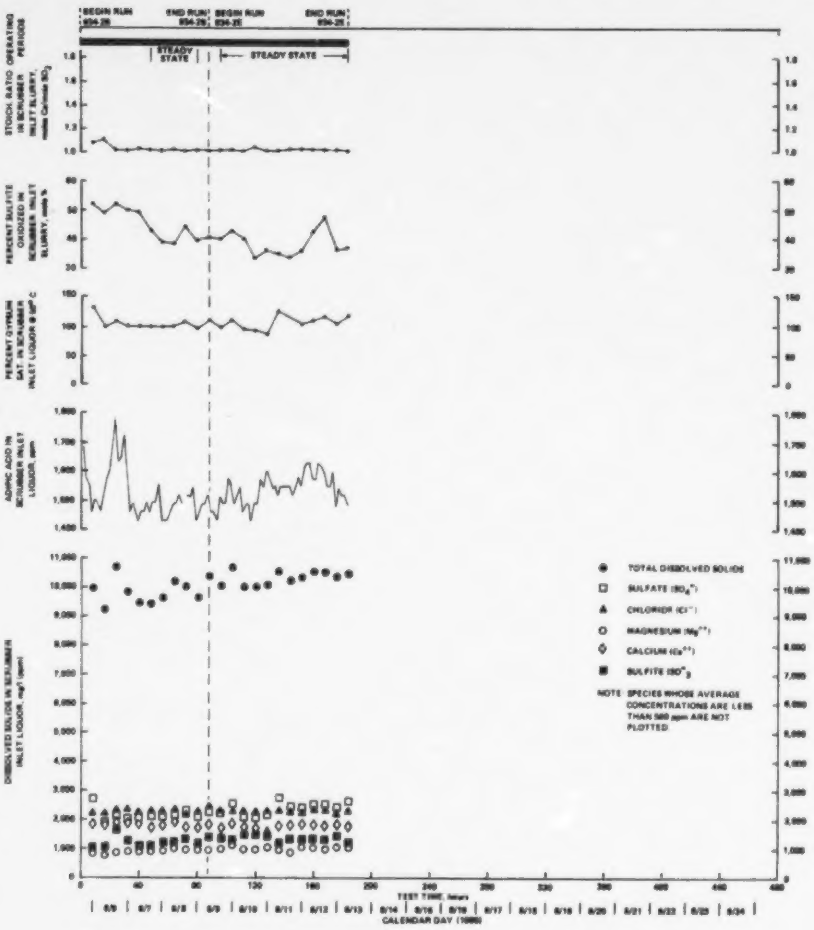


Figure I-30. Operating Data For TCA Runs 934-2B And 934-2E



934-2B

Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 37.2 min
Adipic Acid Dry Fed to EHT
Limestone Addition to EHT
Solids Recirculated = 9.1-10.1 wt %
Total Pressure Drop, Excluding Mist Elim. = 7.0-7.6 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.32 in. H_2O
Discharge (Clarifier & Drum Filter) Solids Concentration = 70-75 wt %
Clarified Liquid Returned to EHT

934-2E

Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 37.2 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.3-11.5 wt %
Total Pressure Drop, Excluding Mist Elim. = 6.8-7.8 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.32 in. H_2O
Discharge (Clarifer & Drum Filter) Solids Concentration = 66-80 wt %
Clarified Liquid Returned to EHT

Figure I-30 (continued). Operating Data For TCA Runs 934-2B And 934-2E

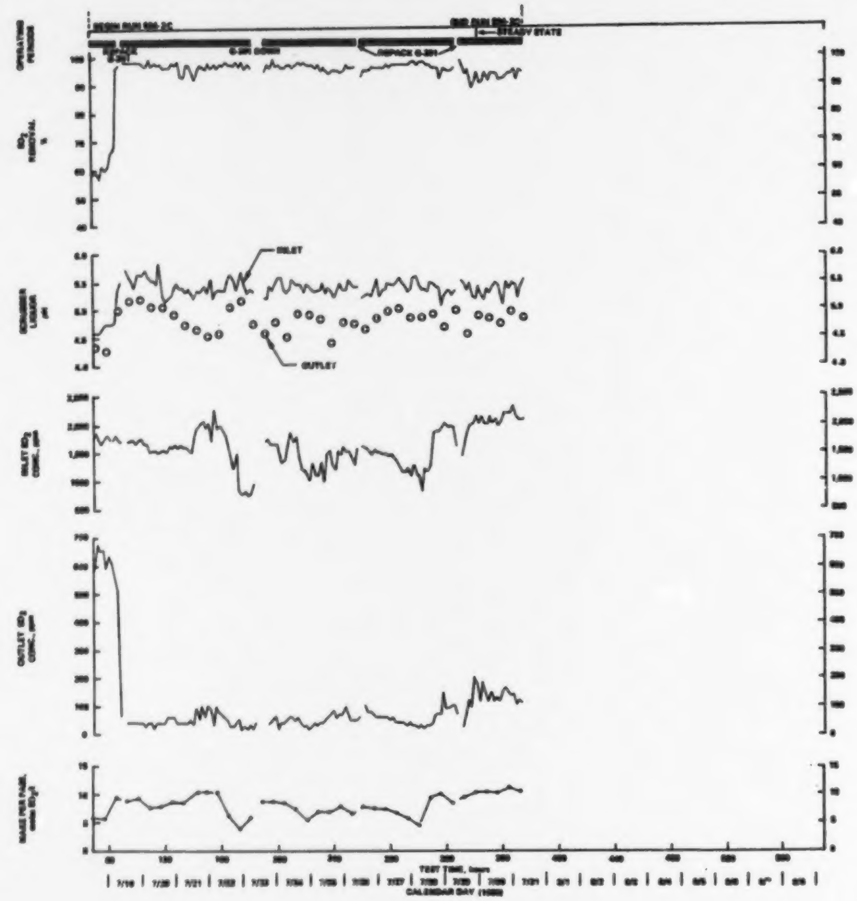
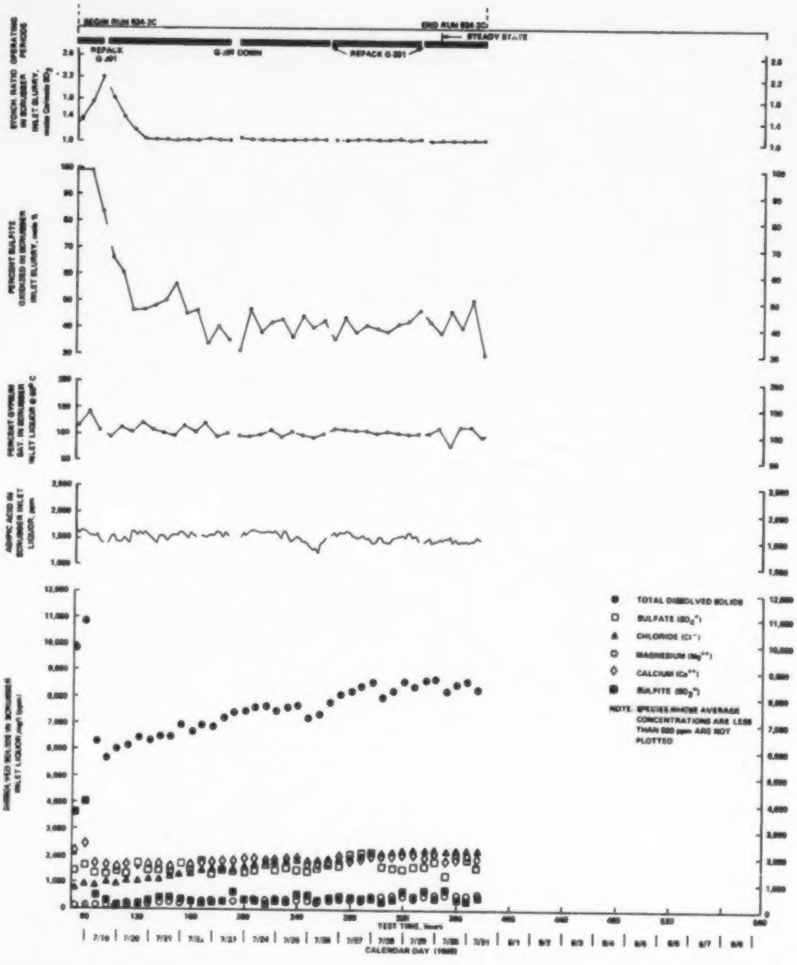


Figure I-31. Operating Data For TCA Run 934-2C



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 37.2 min
Adipic Acid Dry Fed to EHT
Limestome Addition to EHT
Solids Recirculated = 8.7-11.8 wt %
Total Pressure Drop, Exch. Mist Elim. = 6.9-8.7 in. H_2O
Mist Elim. Pressure Drop = 0.28-0.33 in. H_2O
Discharge (Clarifier & Belt Filter) Solids Concentration = 78-79 wt %
Clarified Liquor Returned to EHT

Figure I-31 (continued). Operating Data For TCA Run 934-2C

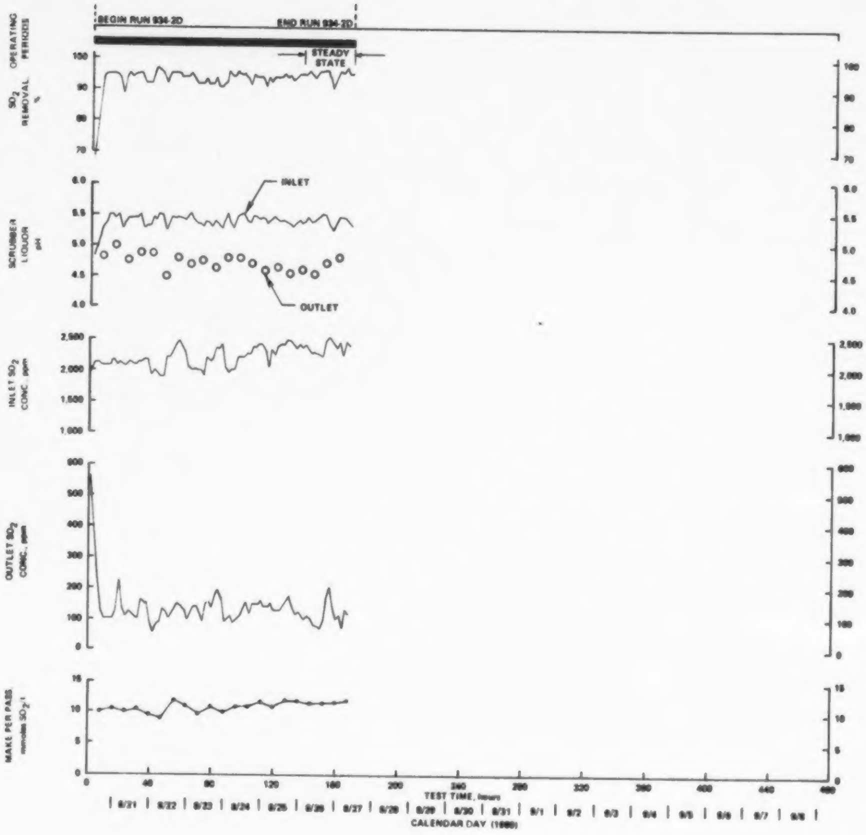
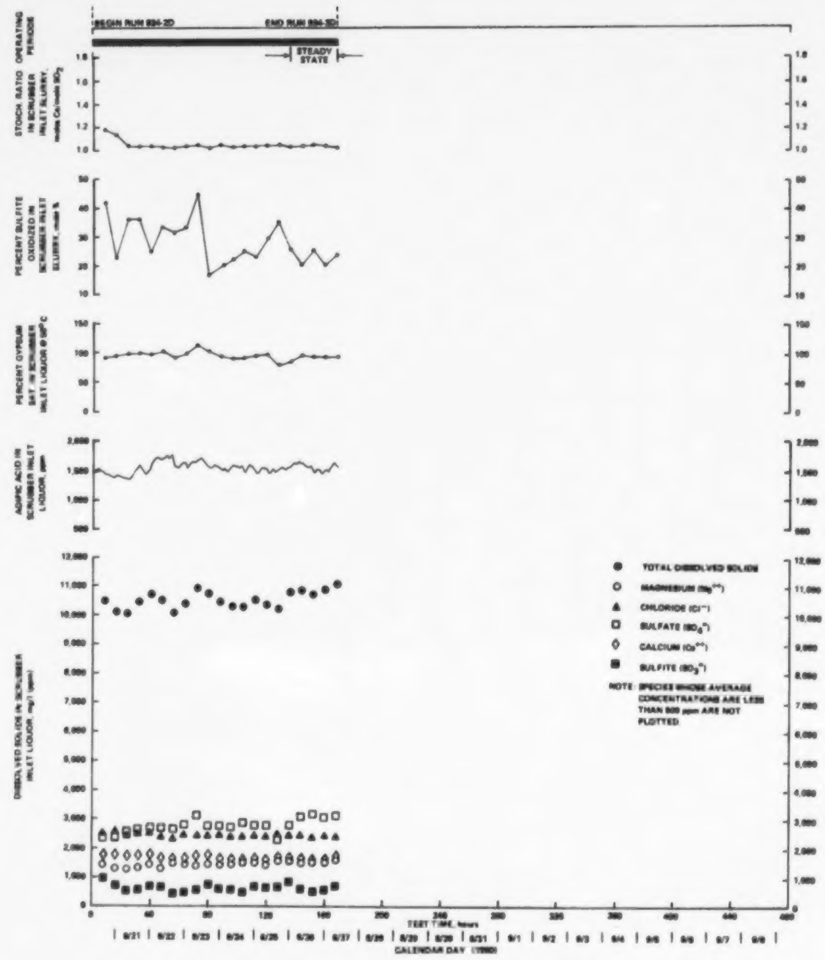


Figure I-32. Operating Data For TCA Run 934-2D



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 37.2 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.7-10.4 wt %
Total Pressure Drop, Excluding Mist Elim. = 8.5-9.5 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.35 in. H_2O
Discharge (Clarifier & Belt Filter) Solids Concentration = 71-76 wt %
Clarified Liquid Returned to EHT

Figure I-32 (continued). Operating Data For TCA Run 934-2D

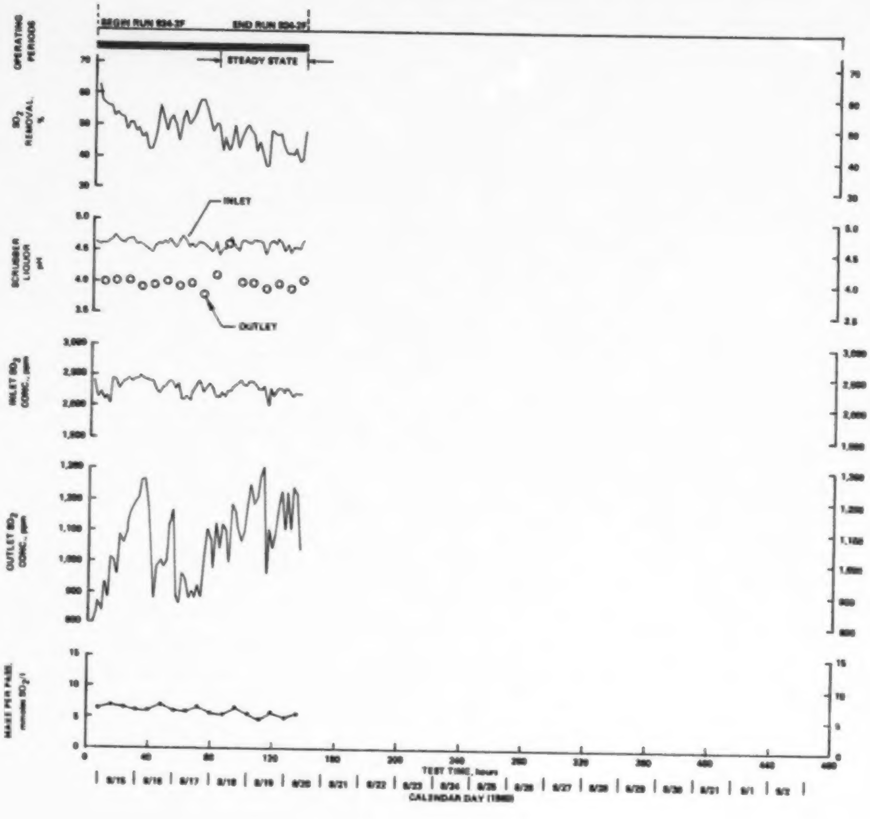
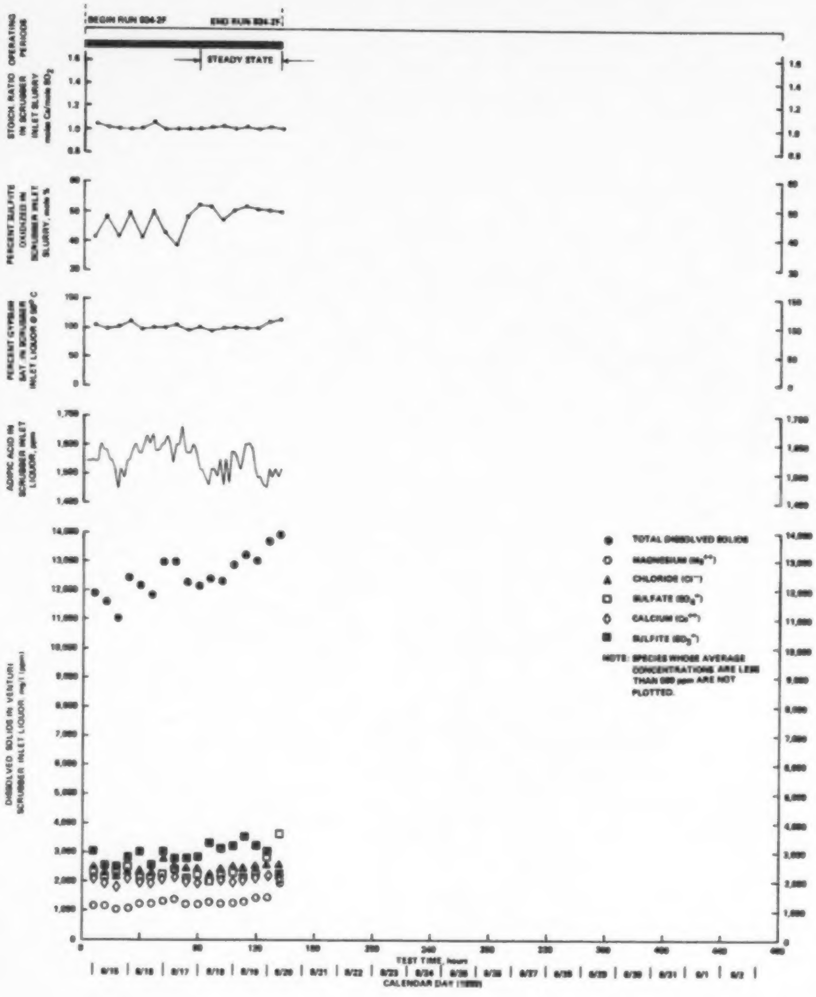


Figure I-33. Operating Data For TCA Run 934-2F



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 125 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 37.2 min
Adipic Acid Dry Fed the Limestone Tank
Solids Recirculated = 8.7-10.1 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.1-8.4 in. H_2O
Mist Elim. Pressure Drop = 0.30-0.34 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 84-88 wt %
Clarified Liquid Returned to EHT

Figure I-33 (continued). Operating Data For TCA Run 934-2F

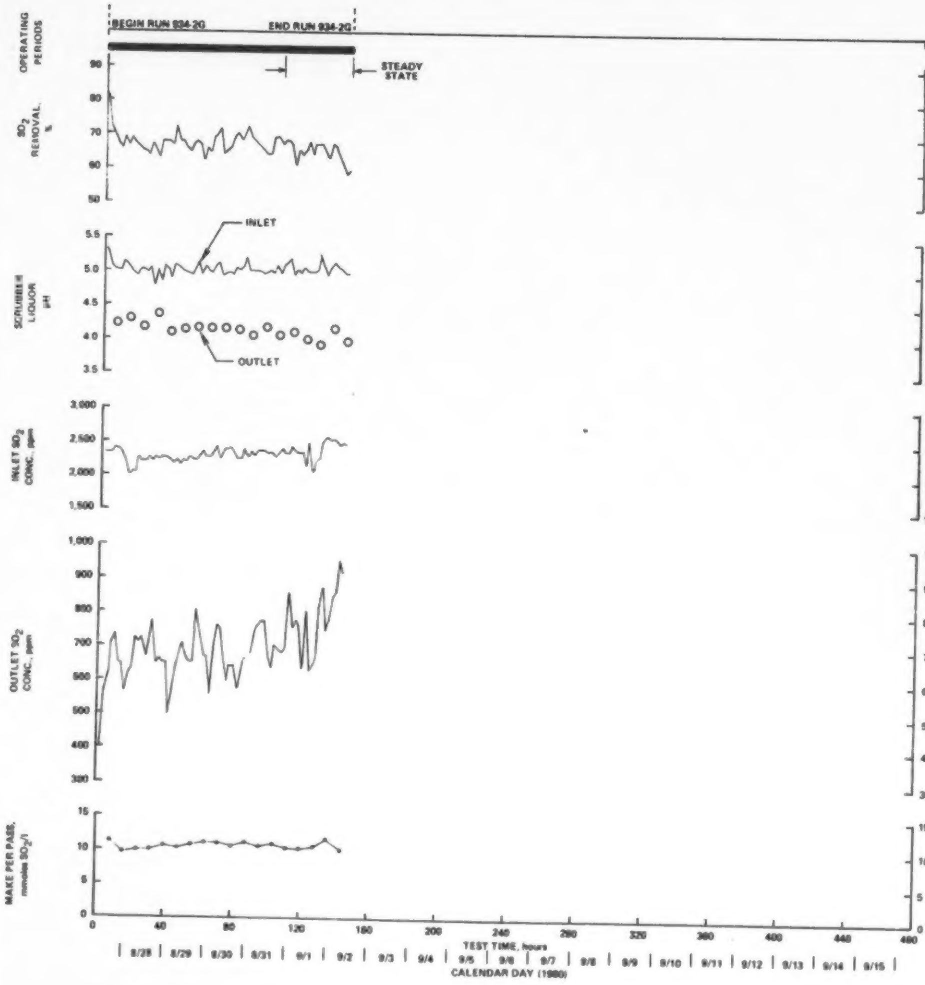
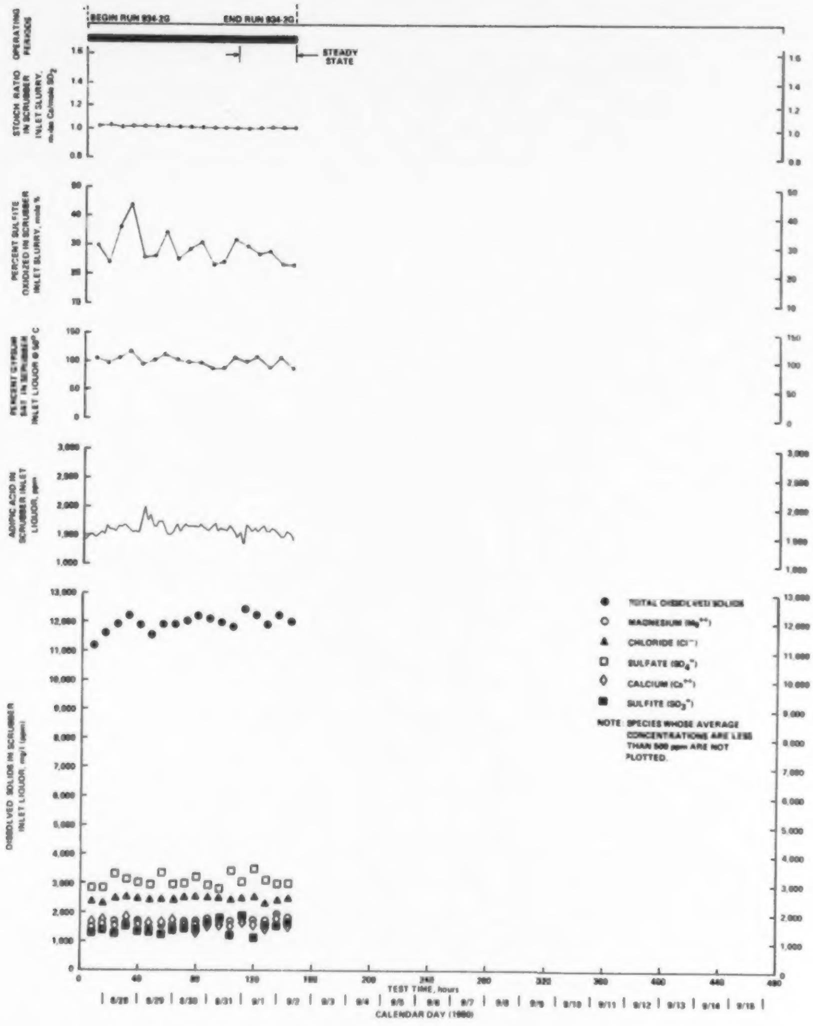


Figure I-34. Operating Data For TCA Run 934-2G



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 50 min
Adipic Acid Dry Fed to the Limestone Tank
Solids Recirculated = 9.3-9.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 5.8-6.4 in. H_2O
Mist Elim. Pressure Drop = 0.29-0.33 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 76-78 wt %
Clarified Liquor Returned to EHT

Figure I-34 (continued). Operating Data For TCA Run 934-2G

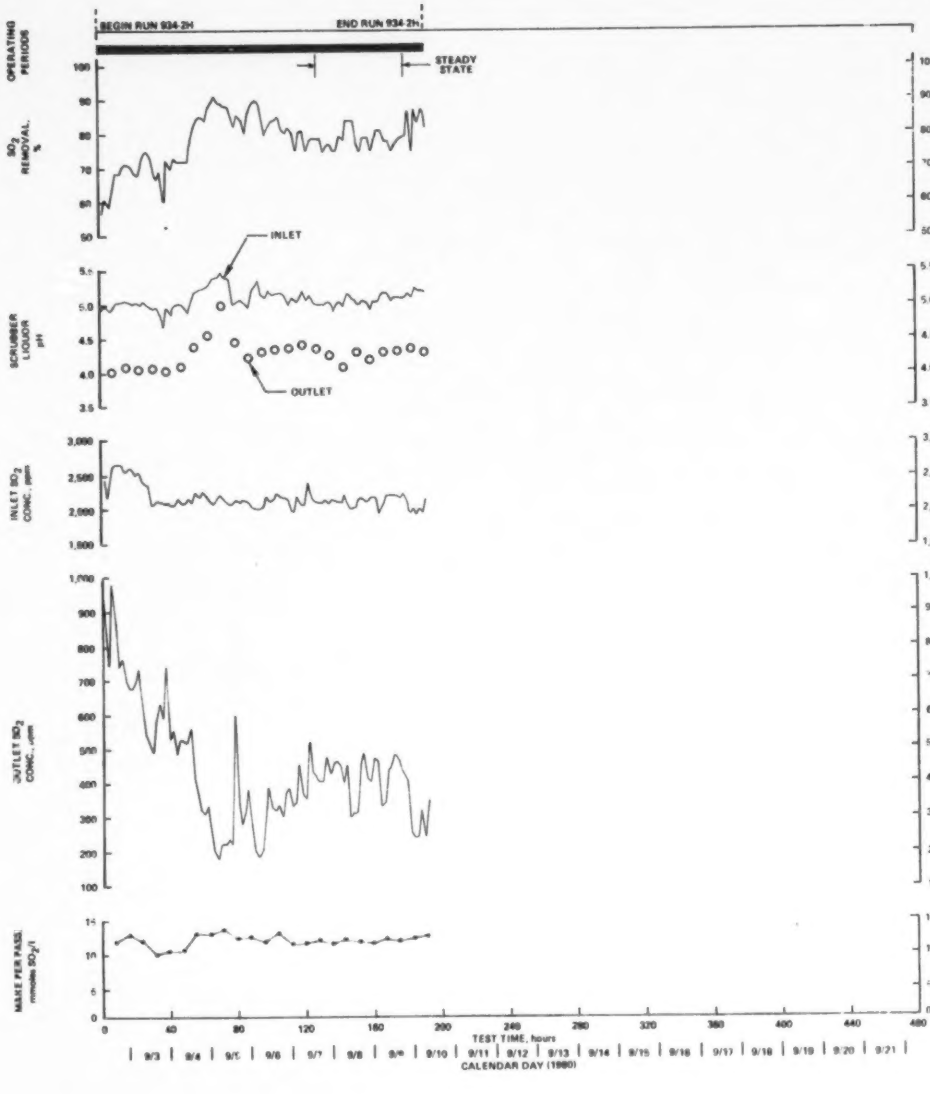
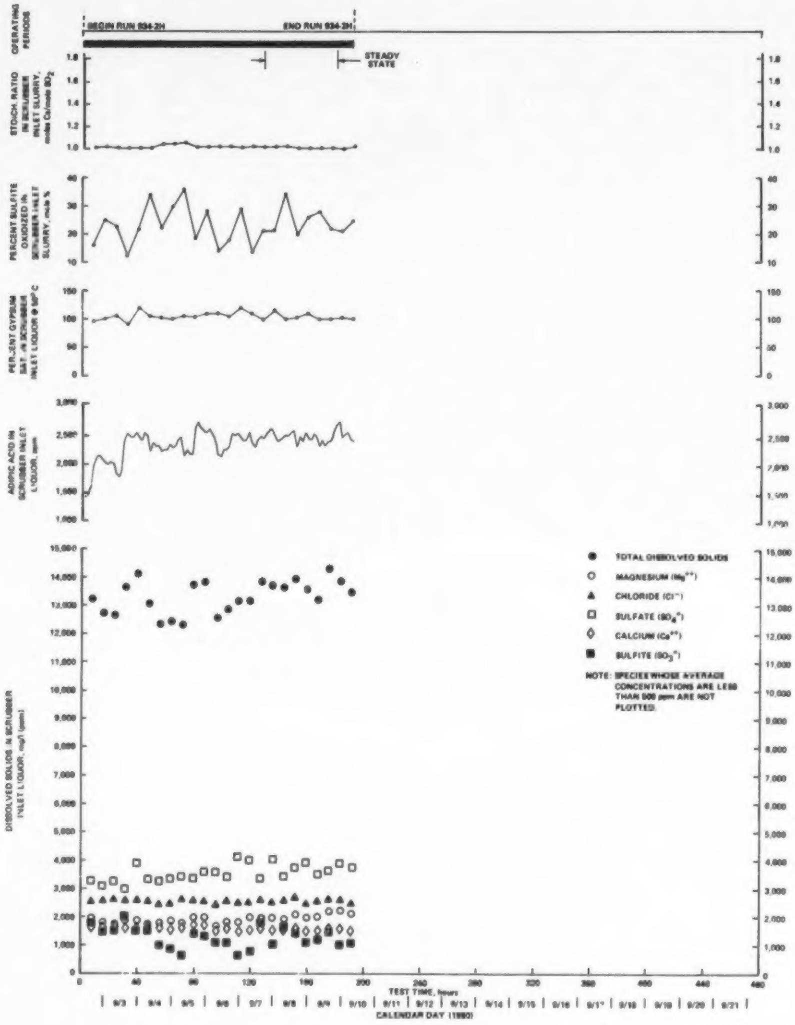


Figure I-35. Operating Data For TCA Run 934-2H



Gas Rate = 30,000 acfm @ 300° F
Scrubber Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 50 min
Adipic Acid Dry to the Limestone Tank
Solids Recirculated = 9.7-10.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.1-6.7 in. H_2O
Mist Elim. Pressure Drop = 0.29-0.34 in. H_2O
Discharge (Clarifier & Belt Filter) Solids
Concentration = 78-81 wt %
Clarified Liquor Returned to EHT

Figure I-35 (continued). Operating Data For TCA Run 934-2H

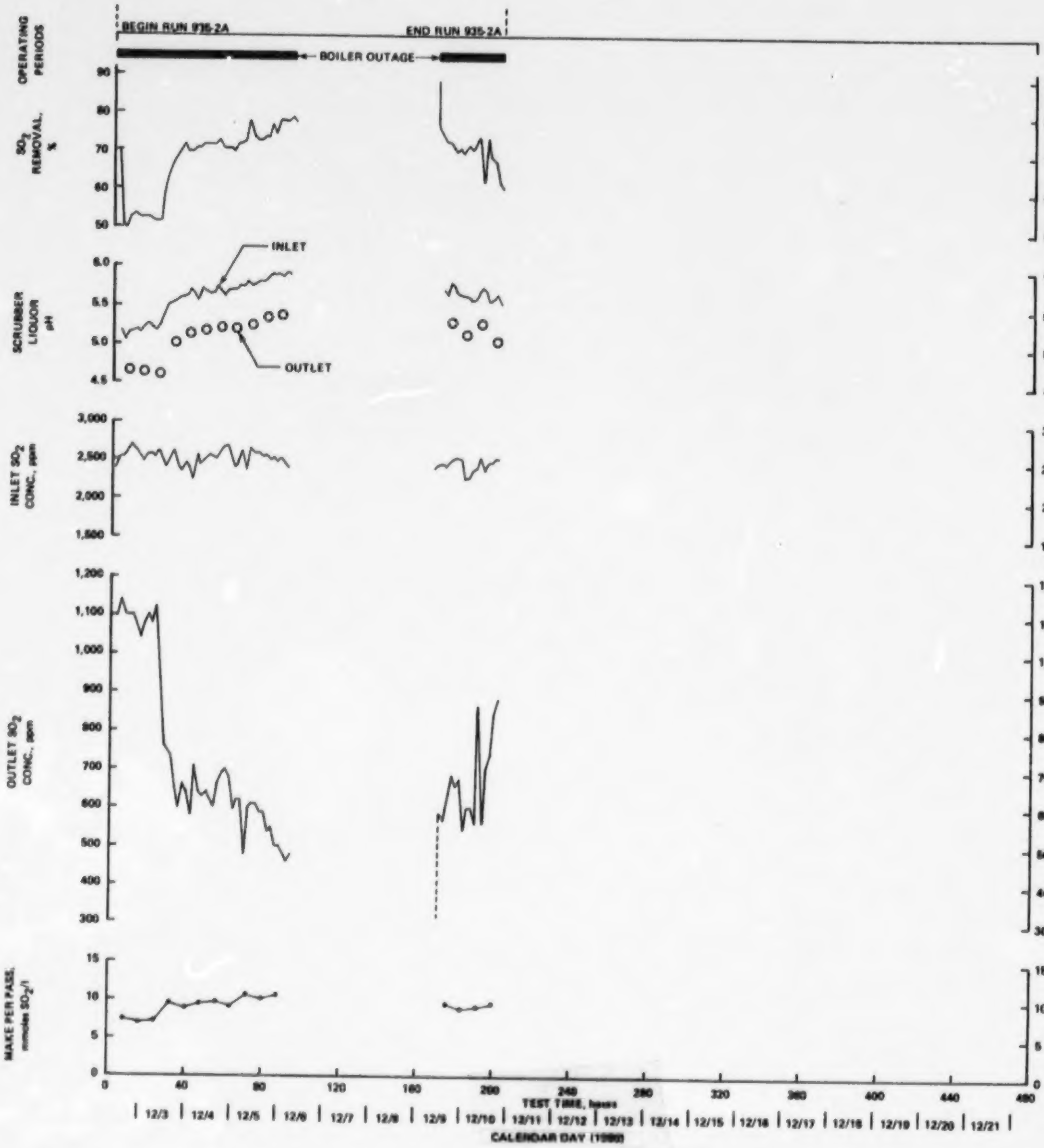
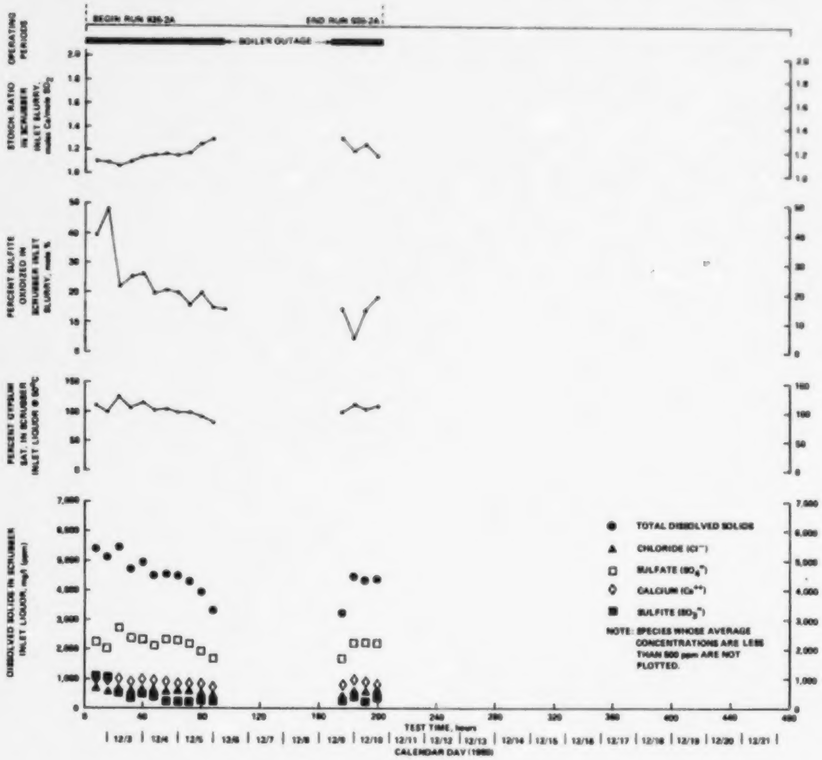


Figure I-36. Operating Data For 1-Ft. Glitsch Grid Packing Run 935-2A



Gas Rate = 30,000 acfm @ 300°F
Scrubber Gas Velocity = 12.5 ft/sec @ 125°F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 12 min
Limestone Addition to EHT
Solids Recirculated = 14.5 to 16.8 wt%
Total Pressure Drop, Excluding Mist Elim.
= 10.6 - 7.8 in. H_2O
Mist Elim. Pressure Drop = 0.3 - 0.2 in. H_2O
Discharge (Clarifier and Belt Filter) Solids
Concentration = 30 - 57 wt%
Clarified Liquor Returned to EHT

Figure I-36 (continued). Operating Data For 1-Ft. Glitsch Grid Packing Run 935-2A

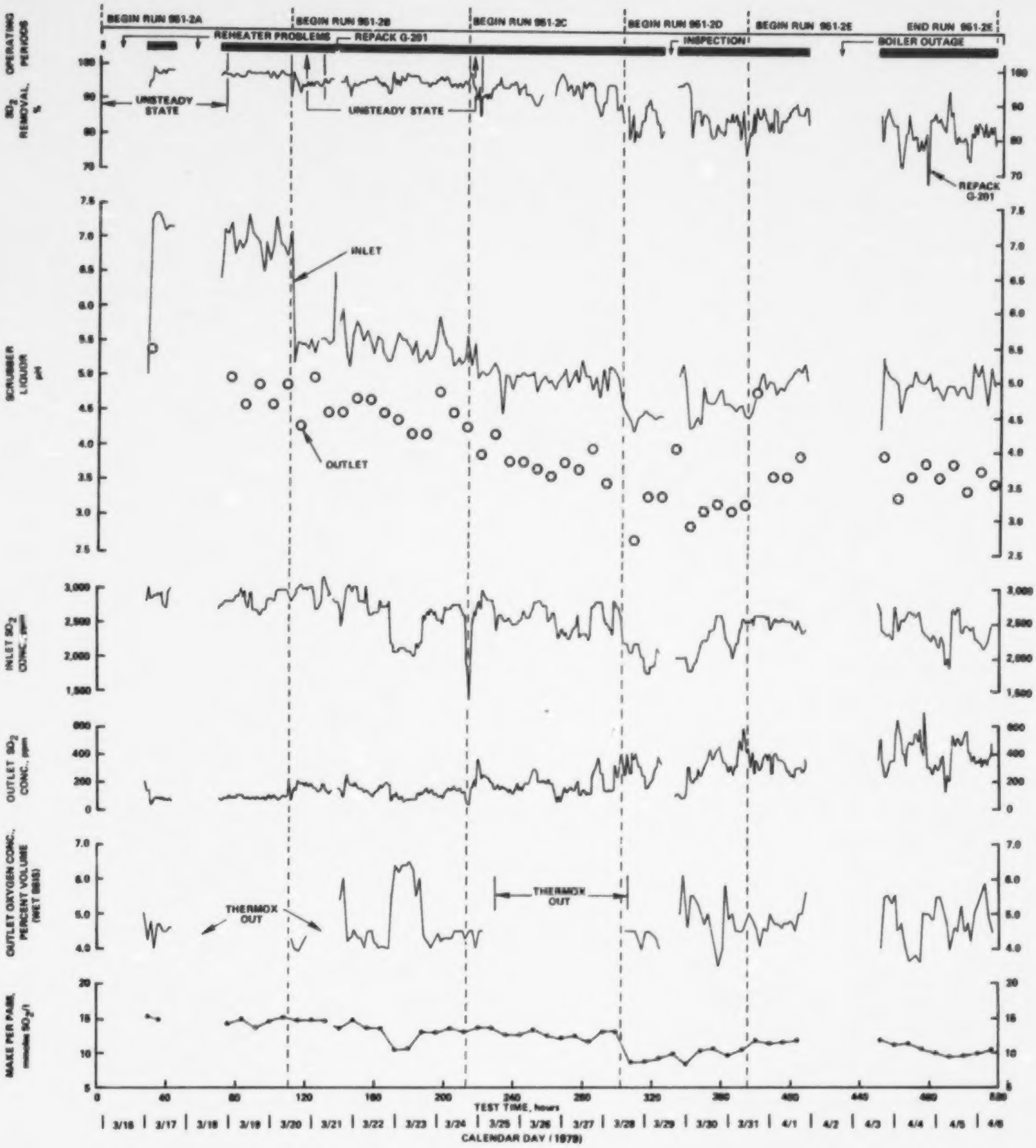
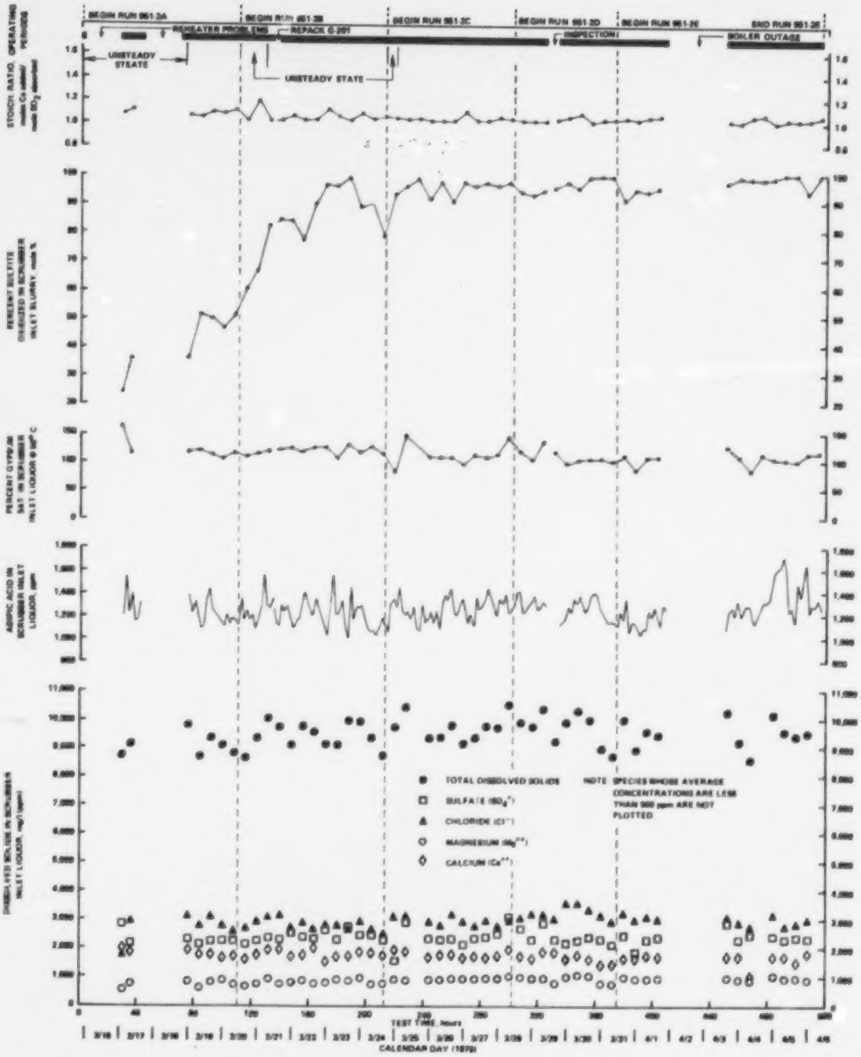
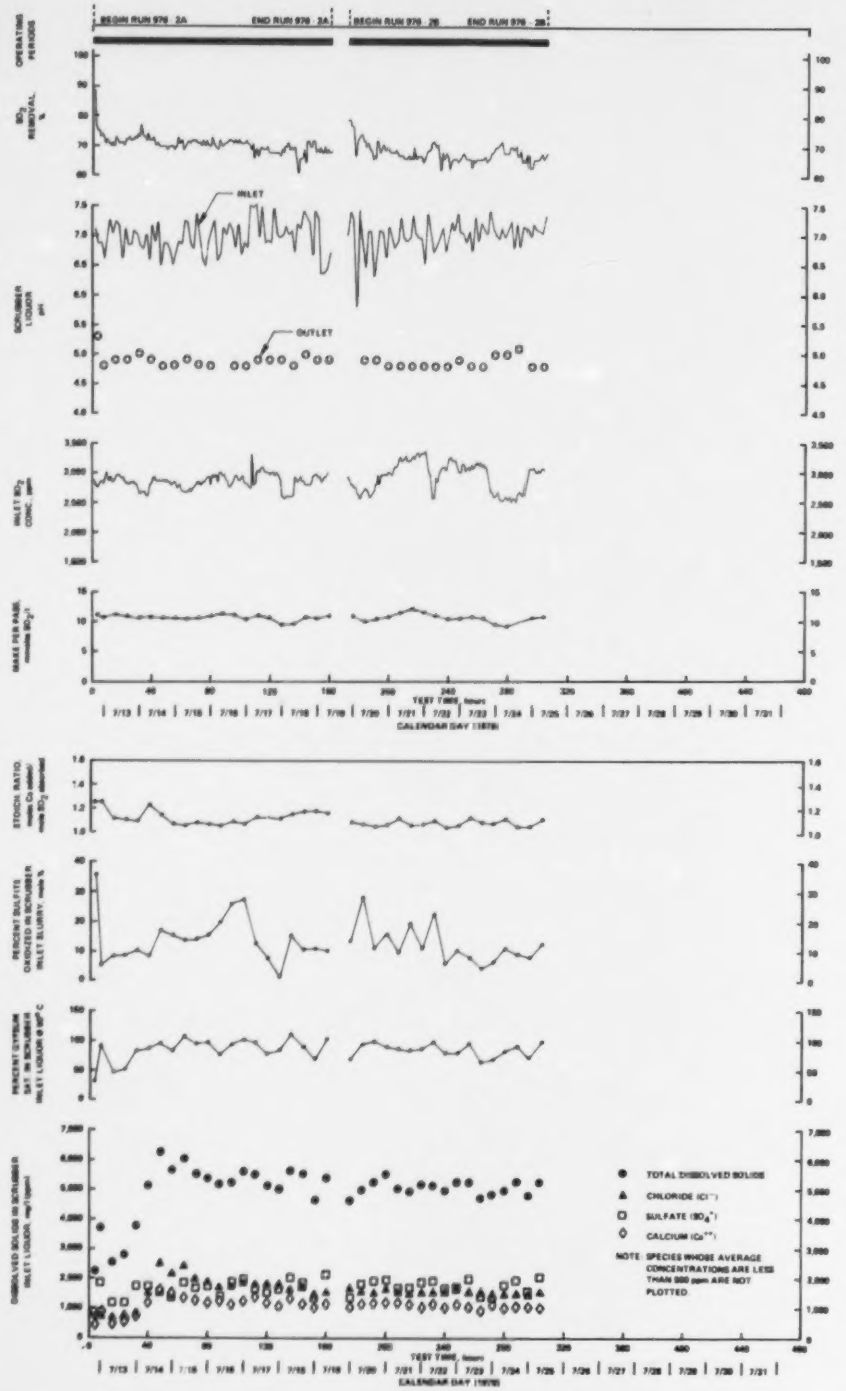


Figure I-37. Operating Data For TCA Runs 951-2A Through 951-2E



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.1 - 8.5 wt %
Lime and Adipic Acid Addition to Oxidation Tank
Discharge (Clarifier & Centrifuge) Solids
Concentration = 59 - 76 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.6 - 12.0 in. H_2O
Mist Elim. Pressure Drop = 0.51 - 0.63 in. H_2O
Air Flow Rate to Oxidizer = 220 scfm
Oxidation Tank Residence Time = 4.1 min
Oxidation Tank Level = 17 ft

Figure I-37 (continued). Operating Data For TCA Runs 951-2A Through 951-2E



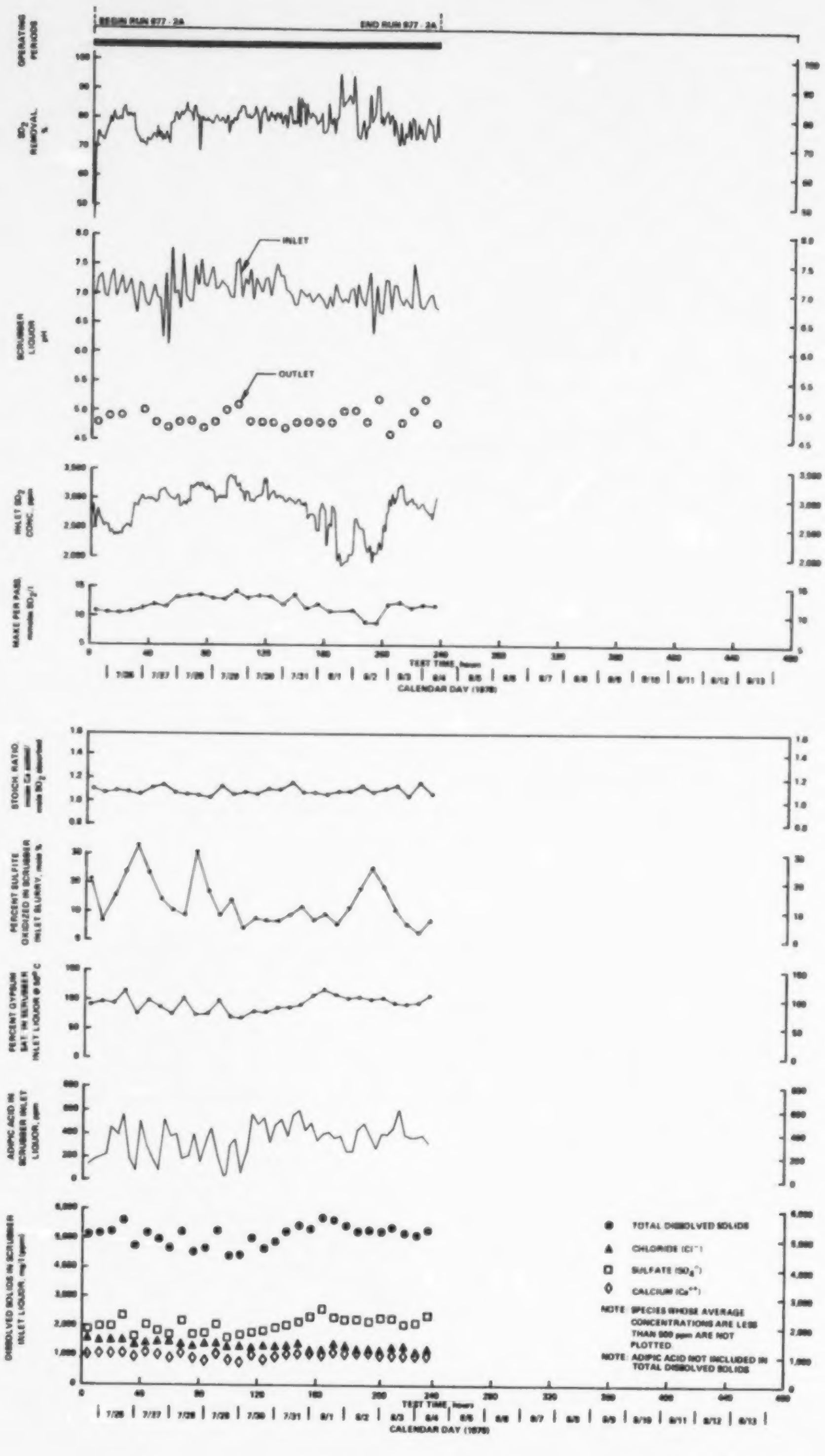
976 - 2A

Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 14.2 - 15.6 wt %
Total Pressure Drop, Excluding Mist Elim. = 6.6 - 8.7 in. H_2O
Mist Elim. Pressure Drop = 0.53 - 0.65 in H_2O
Discharge (Clarifier & Centrifuge) Solids Concentration = 60 - 66 wt %
Lime Addition to internal Downcomer

976 - 2B

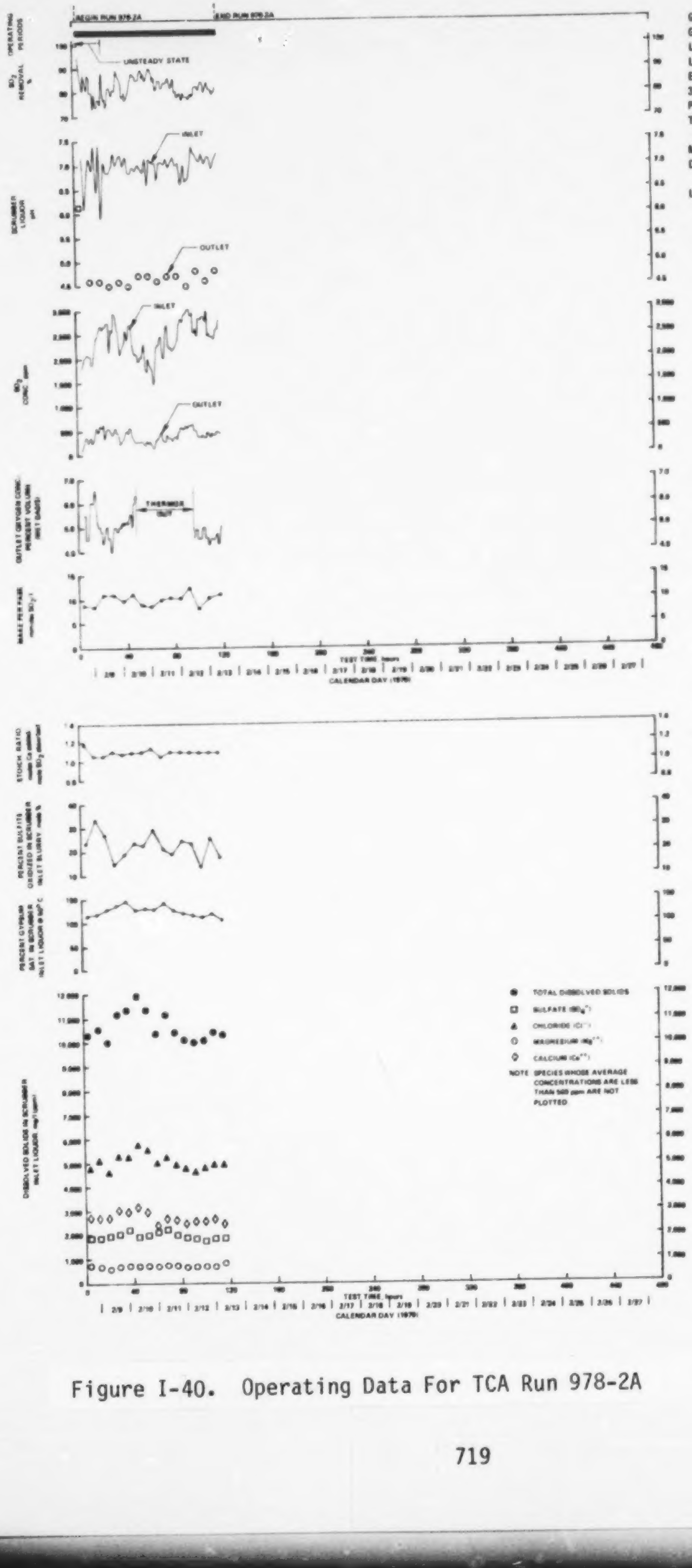
Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.5 - 8.7 wt %
Total Pressure Drop, Excluding Mist Elim. = 6.6 - 7.7 in. H_2O
Mist Elim. Pressure Drop = 0.52 - 0.60 in. H_2O
Discharge (Clarifier & Centrifuge) Solids Concentration = 60 - 66 wt %
Lime Addition to Internal Downcomer

Figure I-38. Operating Data For TCA Runs 976-2A And 976-2B



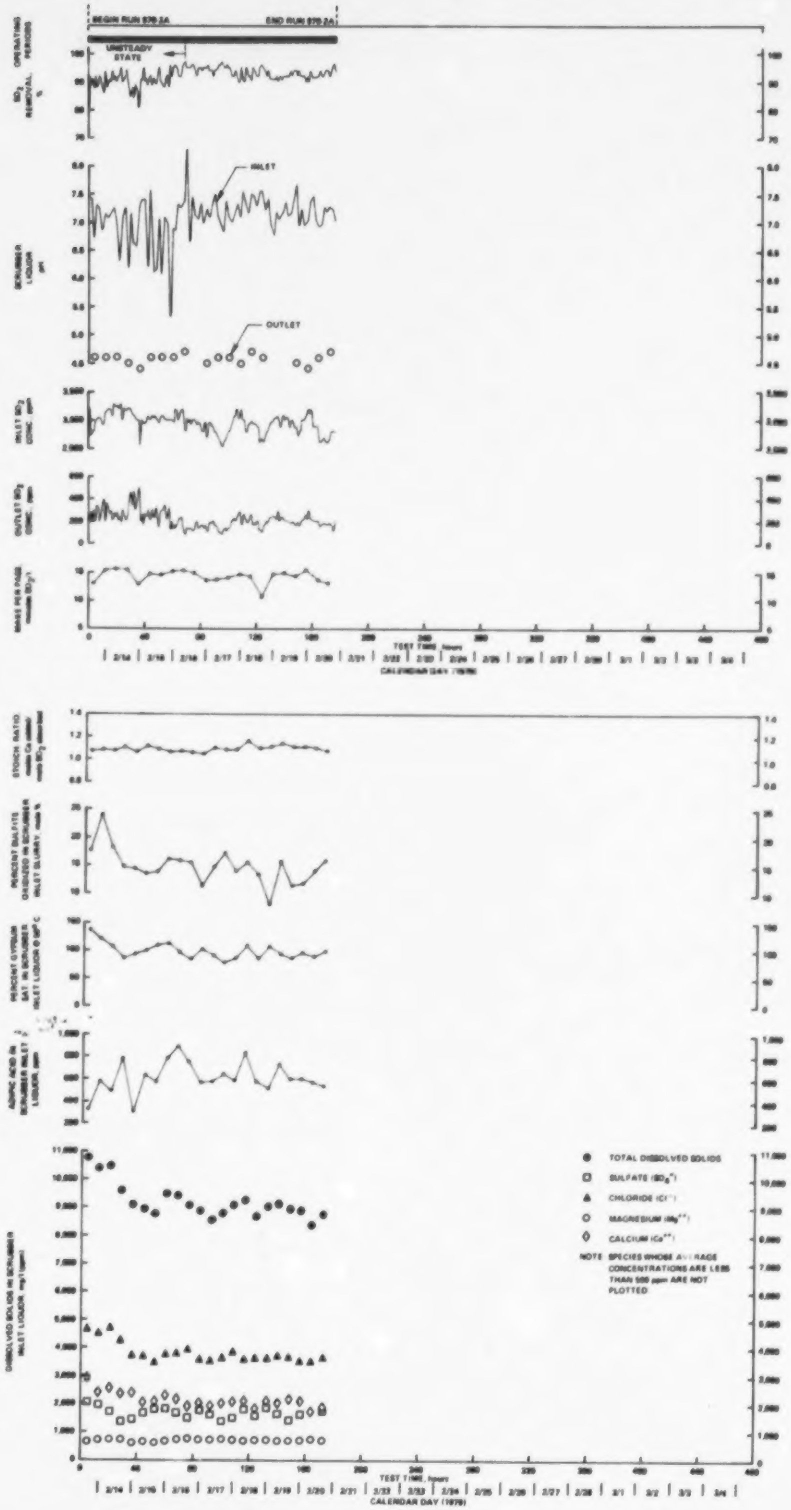
Gas Rate = 30,000 acfm @ 300°F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.4 - 8.8 wt %
Total Pressure Drop, Excluding Mist Elim. = 6.4 - 8.0 in. H_2O
Mist Elim. Pressure Drop = 0.54 - 0.67 in. H_2O
Discharge (Clarifier & Centrifuge) Solids Concentration = 57 - 64 wt %
Lime Addition to Internal Downcomer
Adipic Acid Dry Fed to EHT

Figure I-39. Operating Data For TCA Run 977-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 6.8 - 9.4 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.4 - 9.5 in. H_2O
Mist Elim. Pressure Drop = 0.43 - 0.53 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 60 wt %
Lime Addition to EHT

Figure I-40. Operating Data For TCA Run 978-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.2 - 9.0 wt %
Total Pressure Drop, Excluding Mist Elim.
= 8.1 - 9.5 in. H_2O
Mist Elim. Pressure Drop = 0.46 - 0.58 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 56 wt %
Lime & Adipic Acid Addition to EHT

Figure I-41. Operating Data For TCA Run 979-2A

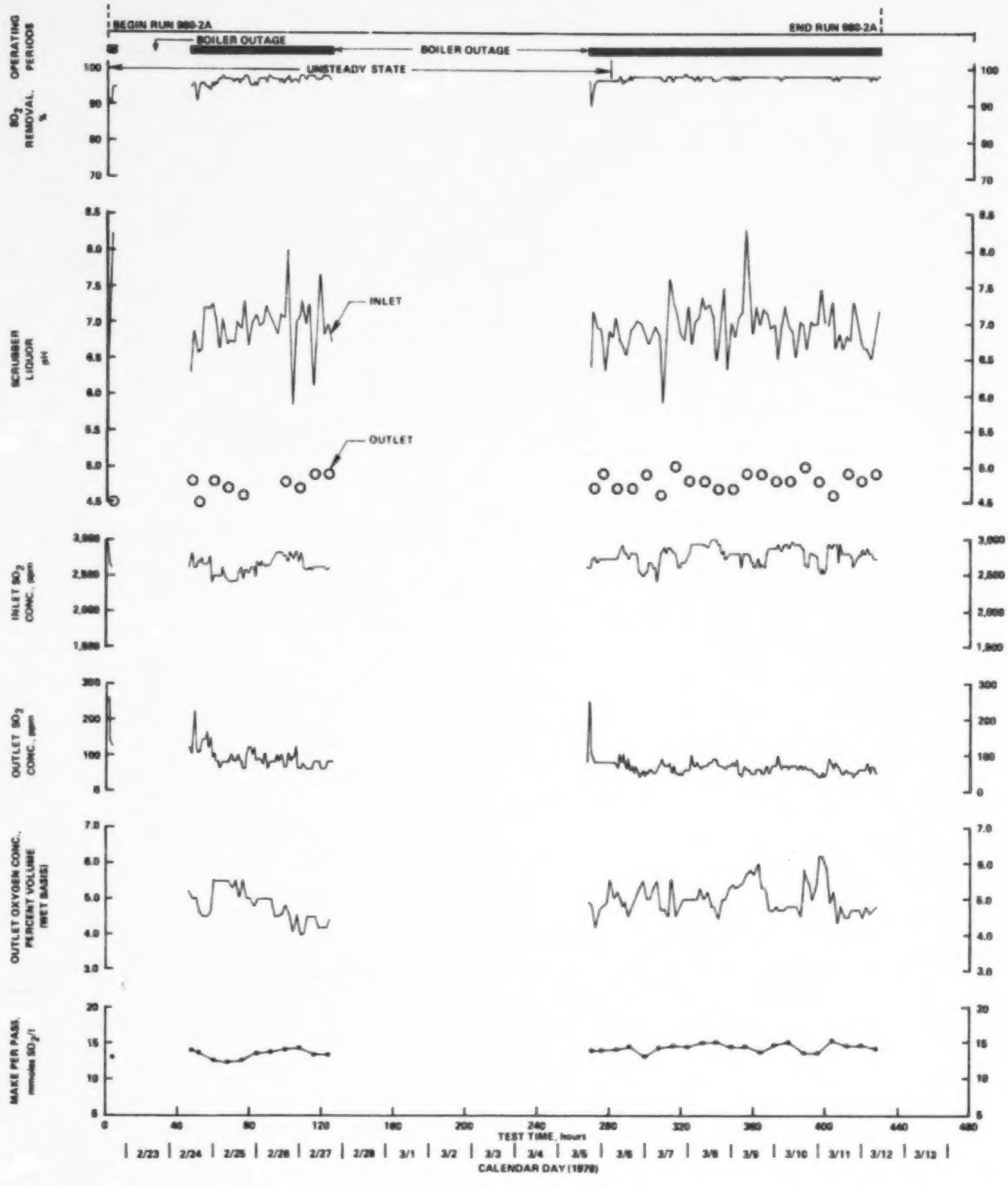
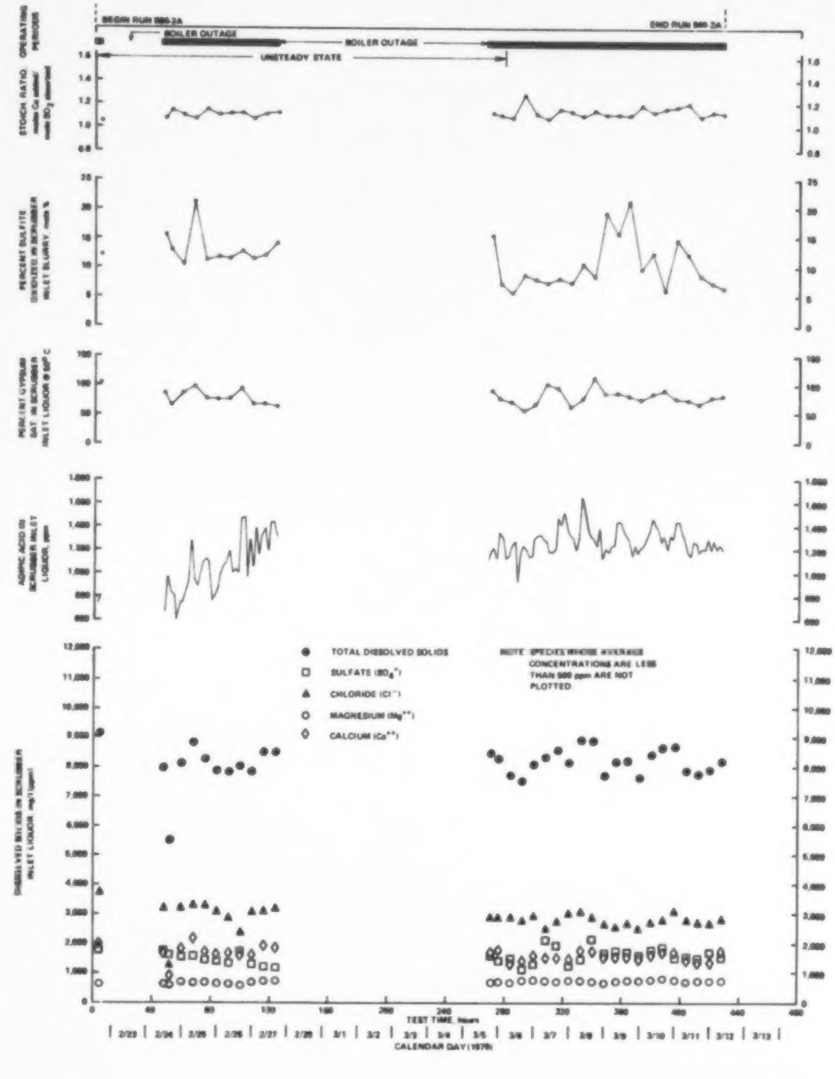


Figure I-42 Operating Data For TCA Run 980-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 1200 gpm
L/G = 50 gal/Mcf
EHT Residence Time = 4.1 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.9 - 8.9 wt %
Total Pressure Drop, Excluding Mist Elim.
= 7.7 - 8.7 in. H_2O
Mist Elim. Pressure Drop = 0.48 - 0.62 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 53 - 61 wt %
Lime and Adipic Acid Addition to EHT

Figure I-42 (continued). Operating Data For TCA Run 980-2A

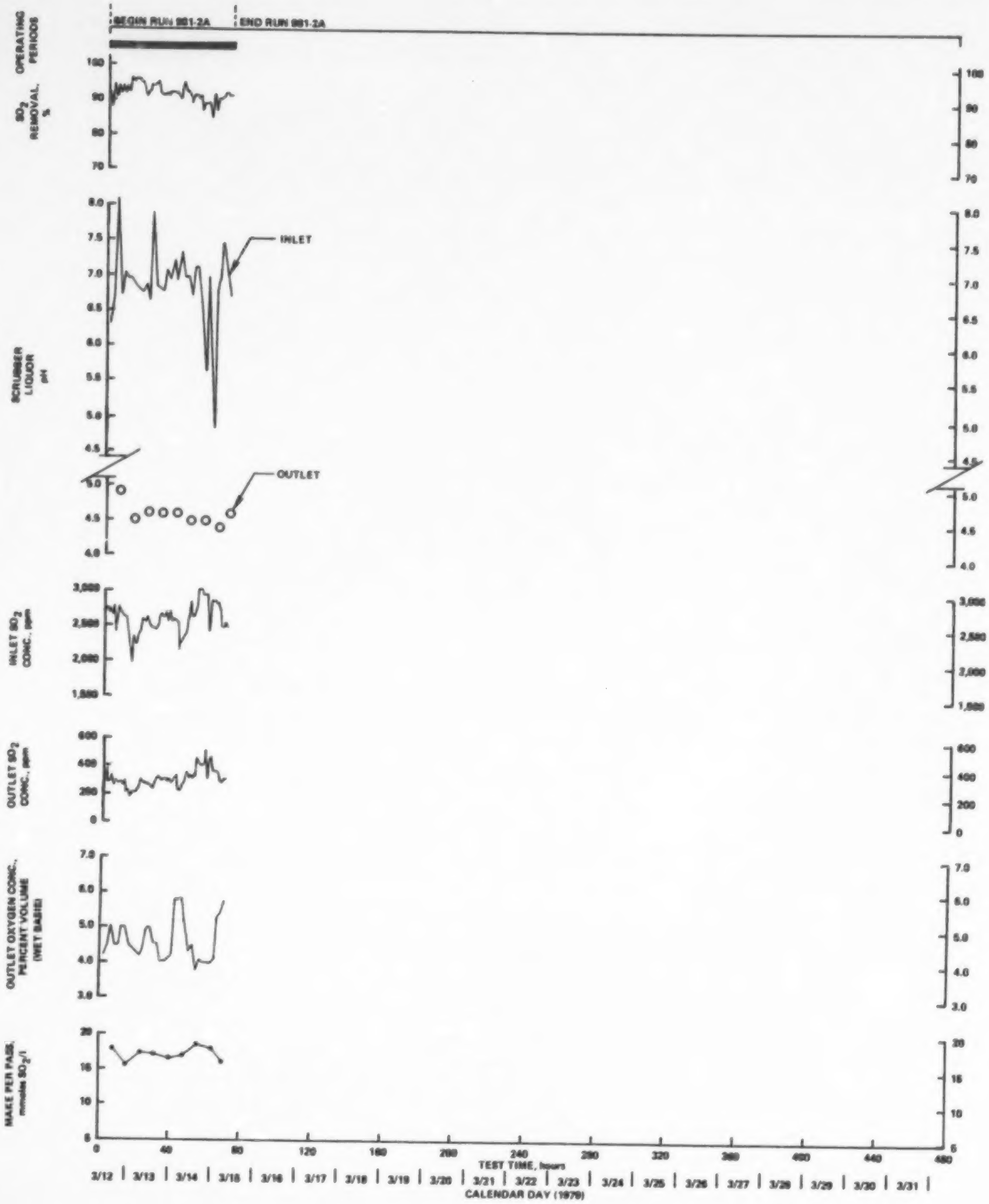
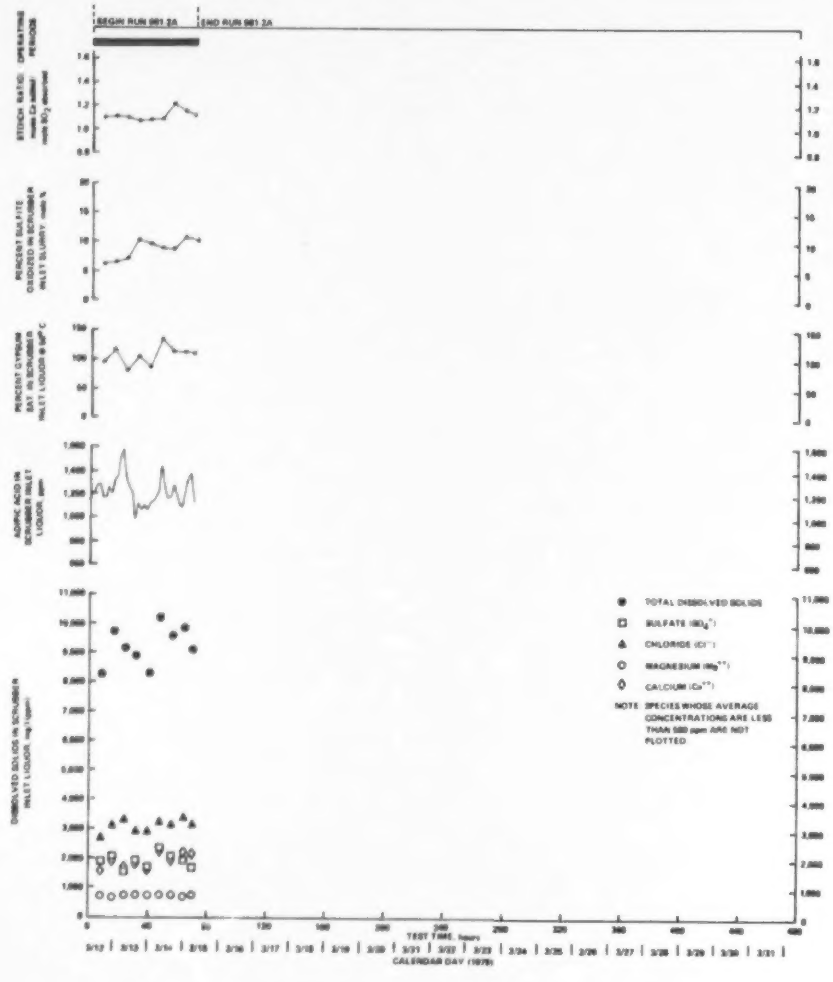


Figure I-43 Operating Data For TCA Run 981-2A



Gas Rate = 30,000 acfm @ 300° F
Gas Velocity = 12.5 ft/sec @ 125° F
Liquor Rate = 900 gpm
L/G = 37 gal/Mcf
EHT Residence Time = 5.4 min
3 Beds, 5 in. spheres/bed
Percent Solids Recirculated = 7.8 - 8.6 wt %
Total Pressure Drop, Excluding Mist Elim.
= 6.7 - 8.0 in. H_2O
Mist Elim. Pressure Drop = 0.45 - 0.60 in. H_2O
Discharge (Clarifier & Centrifuge) Solids
Concentration = 58 - 61 wt %
Lime and Adipic Acid Addition to EHT

Figure I-43 (continued). Operating Data For TCA Run 981-2A

APPENDIX J

AVERAGE LIQUOR COMPOSITIONS FOR THE TCA TESTS

The values in these tables are averages for steady-state operating periods.

Percent sulfite oxidized is measured in the bleed stream from the scrubber system.

Calculated Percent Gypsum Saturation = (activity Ca^{++}) x (activity $SO_4^{=}$) x 100/ (solubility product at 50°C).

Estimated solubility product for $CaSO_4 \cdot 2H_2O$ at 50°C is 2.2×10^{-5} (Reference 28).

Table J-1

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration.(mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
625-2A	58	16	TCA Inlet	8.00	1495	360	40	55	155	1805	-	-	2160	-	6070	105	4.8
			TCA Outlet	5.15	1695	370	40	55	850	1970	-	-	2135	-	7115	120	4.1
901-2A(1)	77	97.5	TCA Inlet	5.05	2120	950	90	140	1510	2780	-	-	2530	1530	11,655	135	12.5
			TCA Outlet	4.80	2320	930	90	135	2225	2740	-	-	2635	1530	12,610	140	11.8
(2)	60	17	TCA Inlet	5.20	1910	965	75	140	320	2695	-	-	2595	1480	10,180	125	16.4
			TCA Outlet	4.75	1930	975	85	135	490	2860	-	-	2550	1480	10,505	135	17.3
(3)	78	96	TCA Inlet	5.15	1915	800	85	120	810	2680	-	-	2100	1395	9910	130	13.8
			TCA Outlet	4.80	2065	790	90	125	1470	2605	-	-	2055	1395	10,600	135	16.0
(4)	73	99	TCA Inlet	5.30	1595	870	85	135	85	2545	-	-	2320	1495	9135	110	11.9
			TCA Outlet	4.75	1660	880	80	140	740	2345	-	-	2320	1495	9665	105	14.5
(5)	78	97.5	TCA Inlet	5.20	1920	890	90	130	825	2760	-	-	2195	1390	10,205	130	15.6
			TCA Outlet	4.95	2020	880	85	130	1370	2840	-	-	2175	1390	10,895	140	14.0
901-2H	77	99	TCA Inlet	5.30	1655	940	90	135	220	2625	-	-	2295	1575	9540	110	15.5
			TCA Outlet	4.85	1785	920	90	130	630	2750	-	-	2255	1575	10,140	125	16.0
901-2I	78	98.5	TCA Inlet	5.30	1805	990	100	130	330	2750	-	-	2585	1530	10,225	120	14.0
			TCA Outlet	4.95	1925	965	105	130	770	2945	-	-	2575	1530	10,950	135	12.2
901-2J(1)	63	24	TCA Inlet	5.25	1700	935	85	120	325	2740	-	-	2305	1525	9735	120	14.0
			TCA Outlet	4.95	1745	925	85	120	500	2695	-	-	2325	1525	9920	120	15.1
(2)	75	94	TCA Inlet	5.25	2075	990	90	135	1055	2580	-	-	3060	1485	11,470	120	10.1
			TCA Outlet	4.90	2215	1030	90	135	1695	2835	-	-	3060	1485	12,545	135	9.4
902-2A	78	98.6	TCA Inlet	5.20	2025	995	90	160	675	2800	-	-	2825	1560	11,130	130	12.7
			TCA Outlet	4.85	2280	980	90	150	1280	2965	-	-	2840	1560	12,145	150	13.2
902-2B	76	97.5	TCA Inlet	5.15	2140	1070	115	140	1145	2885	-	-	2855	1630	11,980	135	13.4
			TCA Outlet	4.80	2290	1085	110	135	1760	3185	-	-	2825	1630	13,020	155	12.4
903-2A	78	99.1	TCA Inlet	5.30	1470	1005	100	115	55	2520	-	-	2405	1500	9170	95	14.8
			TCA Outlet	4.65	1585	990	80	120	660	2835	-	-	2360	1500	10,130	120	12.5
903-2B	88	99.5	TCA Inlet	5.40	1610	905	90	115	70	2350	-	-	2505	1565	9210	100	13.4
			TCA Outlet	4.85	1770	880	90	105	455	2890	-	-	2480	1556	10,235	130	9.6

Table J-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration,(mg/1) ppm											Calculated Percent Gypsum Saturation @ 50^{o}C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$SO_3^{=}$	$SO_4^{=}$	Fe	Mn	Cl^{-}	Adipate	Total		
904-2A	85	98.0	TCA Inlet	5.50	865	240	30	40	245	2240	-	-	340	-	4000	110	8.3
			TCA Outlet	5.15	1055	245	30	40	800	2370	-	-	340	-	4880	125	6.9
904-2B	86	99.1	TCA Inlet	5.40	1135	400	50	60	225	2175	-	-	1300	-	5345	110	8.6
			TCA Outlet	5.15	1345	380	55	60	735	2340	-	-	1270	-	6185	130	7.3
904-2C	88	99.4	TCA Inlet	5.35	1095	540	75	100	95	2460	-	-	1460	-	5825	110	10.7
			TCA Outlet	5.00	1255	545	75	105	485	2755	-	-	1455	-	6675	130	7.5
904-2D	81	97.4	TCA Inlet	5.10	1710	595	80	120	1040	2955	-	-	2135	-	8635	155	3.2
			TCA Outlet	4.95	1880	575	80	120	1655	2785	-	-	2130	-	9225	155	4.7
904-2E	85	99.1	TCA Inlet	5.30	1495	660	80	150	20	2190	-	-	2775	-	7370	110	9.0
			TCA Outlet	4.90	1610	650	85	150	225	2590	-	-	2750	-	8060	130	5.0
904-2F	86	98.1	TCA Inlet	5.45	1405	715	85	150	10	2090	-	-	2710	-	7165	100	12.2
			TCA Outlet	4.95	1580	730	80	145	170	2525	-	-	2725	-	7955	125	10.0
904-2G	43	99.6	TCA Inlet	5.55	1205	475	60	95	25	1930	-	-	1980	-	5770	95	7.7
			TCA Outlet	4.95	1285	495	60	95	175	2270	-	-	1965	-	6345	115	4.6
904-2H	39	99.2	TCA Inlet	5.40	1330	440	65	100	235	2030	-	-	1865	-	6065	110	9.0
			TCA Outlet	5.15	1380	430	65	105	445	2175	-	-	1845	-	6445	120	5.7
904-2I	34	99.0	TCA Inlet	5.30	1240	420	60	85	20	1715	-	-	2030	-	5570	90	8.0
			TCA Outlet	5.00	1415	435	60	90	245	1830	-	-	2015	-	6090	105	11.8

Table J-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration,(mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
906-2A	86	99.1	TCA Inlet	5.70	1515	660	100	115	40	1855	-	-	2355	1305	7945	85	10.7
			TCA Outlet	5.15	1760	655	95	125	470	2035	-	-	2355	1305	8800	105	12.5
906-2B	37	99.3	TCA Inlet	5.85	1480	650	120	100	95	1800	-	-	2510	785	7540	85	11.1
			TCA Outlet	5.05	1655	615	95	105	625	2190	-	-	2480	785	8550	110	5.2
906-2C	88	99.6	TCA Inlet	6.10	1465	630	95	115	20	1930	-	-	2290	830	7375	95	12.1
			TCA Outlet	5.35	1655	635	95	115	585	2050	-	-	2290	830	8255	105	11.1
906-2D	87	99.0	TCA Inlet	5.75	1565	640	100	125	30	1775	-	-	2820	760	7815	90	8.4
			TCA Outlet	5.20	1775	625	100	125	425	2025	-	-	2830	760	8665	110	7.2
907-2A	89	100	TCA Inlet	4.75	1530	2030	85	65	290	3620	-	-	2300	2490	12,400	100	33
			TCA Outlet	4.35	1690	2030	80	65	1200	3780	-	-	2290	2490	13,600	115	33
907-2B	91	98	TCA Inlet	4.80	1650	2320	100	75	180	3690	2	28	2530	2700	13,200	100	37
			TCA Outlet	4.55	1810	2290	100	75	875	3970	-	-	2550	2700	14,400	115	35
907-2C	88	99	TCA Inlet	4.75	2110	2240	120	85	830	3340	5	32	2530	2550	13,800	110	41
			TCA Outlet	4.45	2300	2340	120	80	1670	3410	-	-	2510	2520	14,900	120	42
907-2D	88	99.8	TCA Inlet	4.85	1970	2280	135	80	110	3440	-	-	2310	2630	13,000	105	44
			TCA Outlet	4.45	2070	2350	135	80	1000	3540	-	-	2310	2630	14,100	115	44
907-2E	90	99.7	TCA Inlet	4.80	1870	2470	155	90	40	3620	0.4	46	2410	2730	13,400	100	44
			TCA Outlet	4.35	2050	2560	155	90	780	3930	-	-	2420	2730	14,700	120	45

Table J-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration,(mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
907-2F	88	99.7	TCA Inlet	4.80	1710	2420	155	90	120	4150	0.4	49	2500	2470	13,600	110	38
			TCA Outlet	4.35	1830	2320	155	85	715	4290	-	-	2480	2470	14,300	130	37
907-2G	92	99.9	TCA Inlet	4.80	1550	2490	165	100	50	4570	0.3	11	2650	2420	14,000	110	34
			TCA Outlet	4.30	1740	2480	165	100	1260	4870	-	-	2650	2420	15,700	130	32
907-2J	93	99.8	TCA Inlet	5.00	1680	1660	125	75	290	3630	0.5	41	1740	1980	11,200	120	34
			TCA Outlet	4.55	1830	1700	120	75	500	4160	-	-	1720	1980	12,100	145	34
907-2K	91	99.9	TCA Inlet	5.00	1670	1700	120	70	70	3580	1.0	42	1700	2020	10,900	115	37
			TCA Outlet	4.35	1670	1690	120	70	195	3940	-	-	1720	2020	11,400	135	37
907-2L	88	99.9	TCA Inlet	5.15	1800	1900	135	75	185	3730	0.5	46	1980	1790	11,600	120	38
			TCA Outlet	4.40	1980	1880	135	75	725	4200	-	-	1970	1790	12,800	150	37
907-2M	80	91.0	TCA Inlet	5.30	2210	1950	150	85	1530	3510	2.0	53	2330	1570	13,300	125	35
			TCA Outlet	4.80	2400	2110	150	80	1940	3890	-	-	2320	1570	14,500	145	38
926-2A	37	13	TCA Inlet	5.65	1060	215	35	40	295	1565	-	-	1010	-	4220	90	10.1
			TCA Outlet	5.25	1100	215	35	45	340	1610	-	-	1010	-	4355	95	11.3
927-2A	62	19	TCA Inlet	5.30	1515	655	55	110	450	2260	-	-	2445	350	7840	110	5.9
			TCA Outlet	4.95	1550	645	55	110	720	2290	-	-	2380	350	8100	115	5.6
928-2A	59	14	TCA Inlet	5.40	1940	755	70	110	300	1940	-	-	3225	1600	9940	100	5.7
			TCA Outlet	4.95	1965	750	70	105	450	1960	-	-	3225	1600	10125	100	6.7

Table J-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration, (mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
929-2A	59	10	TCA Inlet	5.50	1985	765	70	100	255	2100	-	-	3565	885	9725	110	4.7
			TCA Outlet	5.15	1975	755	70	100	365	2040	-	-	3590	885	9780	110	4.3
930-2A	58	13	TCA Inlet	5.60	1960	825	75	100	190	1560	-	-	4005	700	9415	80	8.2
			TCA Outlet	5.20	1970	830	75	100	265	1510	-	-	4005	700	9455	80	9.2
931-2A	62	24	TCA Inlet	4.95	2105	875	75	125	1025	2160	-	-	4030	840	11,235	110	0.9
			TCA Outlet	4.60	2210	880	75	125	1500	2160	-	-	3990	840	11,780	115	2.9
932-2A	61	21	TCA Inlet	5.30	2860	755	95	110	330	1785	-	-	5250	1620	12,805	110	0.8
			TCA Outlet	4.95	2890	740	95	110	445	1820	-	-	5205	1620	12,925	115	1.5
933-2A	57	24	TCA Inlet	5.45	2180	625	55	80	245	1850	-	-	3875	-	8910	110	8.0
			TCA Outlet	5.10	2230	620	55	75	405	1925	-	-	3875	-	9185	120	7.0
934-2A	85	56	TCA Inlet	4.55	1940	750	45	35	2690	1740	62	-	2240	1540	11,000	90	9.5
			TCA Outlet	4.00	1970	765	50	35	3340	1670	66	-	2220	1540	11,700	90	12.4
934-2B	73	40	TCA Inlet	4.95	1780	940	45	35	1200	2160	16	-	2230	1460	9850	100	17.4
			TCA Outlet	4.25	1890	935	45	35	2140	2180	21	-	2240	1460	10,900	105	17.9
934-2C	78	42	TCA Inlet	5.35	1920	560	40	25	490	1690	-	-	8440	1500	8440	95	14.5
			TCA Outlet	4.80	2020	555	40	25	1140	1820	-	-	9310	1500	9310	110	12.8
934-2D	74	23	TCA Inlet	5.40	1590	1540	60	50	640	3030	1	2	2410	1570	10,900	100	23.6
			TCA Outlet	4.70	1750	1510	60	50	1560	3190	4	2	2400	1570	12,100	115	21.8

Table J-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration,(mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
934-2E	71	38	TCA Inlet	5.00	1770	985	50	35	1330	2360	-	3	2270	1530	10,300	105	14.2
			TCA Outlet	4.25	1930	1040	50	35	2430	2420	-	3	2270	1530	11,700	115	[illegible].4
934-2F	87	50	TCA Inlet	4.60	2080	1400	60	50	3040	2460	45	5	2430	1520	13,100	105	22.8
			TCA Outlet	4.00	2140	1300	60	50	3870	2190	47	5	2420	1520	13,600	105	23.2
934-2G	80	28	TCA Inlet	5.05	1530	1770	65	60	1450	3230	-	-	2440	1570	12,200	95	23
			TCA Outlet	4.00	1770	1730	65	55	2590	3410	-	-	2610	1610	13,800	120	23
934-2H	77	25	TCA Inlet	5.05	1530	2010	60	60	1280	3730	8	3	2560	2480	13,700	95	21
			TCA Outlet	4.25	1680	2010	60	60	2710	3760	-	-	2530	2470	15,300	115	23
935-2A	51	14.8	TCA Inlet	5.75	840	280	50	45	265	2010	0.25	1.6	485	-	3980	95	12
			TCA Outlet	5.25	880	275	50	45	450	2070	-	-	485	-	4260	101	10
951-2A	61	47	TCA Inlet	6.95	1750	760	45	110	165	2230	-	-	2840	1215	9115	105	5.0
			TCA Outlet	4.80	1695	905	50	110	885	2900	-	-	2765	1215	10,525	130	-1.8
951-2B	74	88	TCA Inlet	5.50	1785	820	40	110	245	2425	-	-	2775	1230	9430	115	8.1
			TCA Outlet	4.50	1845	810	40	110	1115	2615	-	-	2735	1230	10,500	130	5.4
951-2C	74	95	TCA Inlet	5.00	1765	910	50	120	230	2360	-	-	2865	1270	9570	110	12.9
			TCA Outlet	3.80	1680	885	50	120	810	2440	-	-	2835	1270	10,090	115	11.7
951-2D	71	96	TCA Inlet	4.60	1645	915	60	140	80	2425	-	-	3185	1260	9710	110	9.1
			TCA Outlet	3.20	1540	900	60	135	205	2725	-	-	3135	1260	9960	115	6.5

Table J-1 (continued)

AVERAGE LIQUOR COMPOSITIONS FOR THE STEADY-STATE PERIODS DURING TCA TESTS

Run No.	Percent Solids Discharged	Percent Sulfite Oxidized	Sample Point	pH	Liquor Species Concentration,(mg/l) ppm											Calculated Percent Gypsum Saturation @ 50°C	Percent Error in Ionic Imbalance
					Ca^{++}	Mg^{++}	Na^+	K^+	$SO_3^=$	$SO_4^=$	Fe	Mn	Cl^-	Adipate	Total		
951-2E	72	98	TCA Inlet	4.95	1700	960	75	140	90	2440	-	-	2875	1330	9610	105	14.0
			TCA Outlet	3.60	1555	960	80	145	565	2710	-	-	2900	1330	10,245	115	10.7
976-2A	63	16	TCA Inlet	7.00	1210	375	40	70	205	1665	-	-	1850	-	5415	90	3.4
			TCA Outlet	4.90	1475	395	45	75	870	2305	-	-	1800	-	6965	130	-0.3
976-2B	63	12	TCA Inlet	7.00	1055	435	40	75	220	1755	-	-	1505	-	5085	85	8.7
			TCA Outlet	4.90	1370	440	40	75	1200	2185	-	-	1470	-	6780	115	4.9
977-2A	61	10	TCA Inlet	6.95	1015	495	30	75	240	2150	-	-	1235	420	5660	90	5.0
			TCA Outlet	4.85	1305	505	30	75	1195	2505	-	-	1235	420	7270	120	3.5
978-2A	60	21	TCA Inlet	7.00	2700	695	50	90	135	1975	-	-	5080	-	10,725	125	4.7
			TCA Outlet	4.65	3030	690	50	90	1075	2120	-	-	5080	-	12,135	140	5.2
979-2A	55	14	TCA Inlet	7.20	1975	700	40	80	180	1635	-	-	3625	620	8855	90	6.9
			TCA Outlet	4.55	2365	710	45	80	1410	2145	-	-	3605	605	10,965	130	6.2
980-2A	57	10	TCA Inlet	6.95	1535	735	30	75	125	1610	-	-	2760	1305	8175	75	6.0
			TCA Outlet	4.80	1780	740	35	75	1035	1855	-	-	2770	1305	9595	95	6.8
981-2A	60	9	TCA Inlet	6.95	1890	730	30	90	210	1955	-	-	3060	1235	9200	100	6.1
			TCA Outlet	4.60	2190	740	30	90	1305	2385	-	-	3050	1235	11,025	125	0.1

APPENDIX K

BECHTEL MODIFIED EQUILIBRIUM COMPUTER PROGRAM

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K.1 INTRODUCTION

The Bechtel Modified Equilibrium Computer Program, which was originally developed by Radian Corporation (Reference 28), takes as input the measured composition (g-mole/liter or ppm) and pH (optional) of an aqueous liquor or slurry containing dissolved Ca, Mg, Na, K, SO_3, SO_4, CO_3, Cl, and adipic acid species. The partial pressures of CO_2 and SO_2 in equilibrium with the liquid may be input instead of the concentrations of carbonate and sulfite species.

The program determines:

- Presence or absence of solid species ($CaCO_3$, $CaSO_3$, $CaSO_4$, $Ca(OH)_2$, $MgCO_3$, $Mg(OH)_2$)
- Concentrations and activity coefficients of individual dissolved ionic and molecular species
- Liquid pH (if unspecified)
- Ionic imbalance of dissolved species (if pH is specified)
- Equilibrium partial pressures of CO_2 and SO_2 gases over the liquid (if unspecified)
- Degree of $CaSO_4 \cdot 2H_2O$ saturation of liquid

K.1.1 Subprogram Descriptions

File Name	File Type	Function
BQ2	FORTRAN IV (G)	CSS* main program FORTRAN file reads input data and calls BEQ.

---

*These files were written for use on the National CSS, Inc., time-sharing system. Program listings for these programs are presented in Section K.3.

File Name	File Type	Function
BQ2IT	FORTRAN IV (G)	Bechtel Modified Equilibrium Program; determines aqueous solution equilibria for the slurry system Ca, Mg, Na, K, SO_2, SO_3, CO_2, Cl, Adipic Acid.
BQ2CON	FORTRAN IV (G)	Calculates equilibrium constants in BEQ.
BEQSOX	FORTRAN IV (G)	Handles special cases of SO_3 and SO_4 solids not covered by BEQ.
BQ2PR	FORTRAN IV (G)	Prints output from BEQ.
LIQ	FORTRAN IV (G)	Calculates liquor gypsum saturation and ionic imbalance (short print-out).
BEQ	EXEC	CSS* executive program operating BEQ.
LIQ	EXEC	CSS* executive program operating LIQ.
BEQ	DATA	Input data file for BEQ.
LIQ	DATA	Input data file for LIQ.

K.1.2 Program Inputs

Data are input to the modified equilibrium computer program (BEQ FORTRAN) through a BEQ DATA file. The format for this file is:

Line 1: Identification statement (up to 80 alpha numeric characters)

Line 2: JP, K1, JS, TK, PSO2, PCO2, SS1, SS2, SS3, IPH, PH

Line 3: CA, MG, NA, K, SO3, SO4, CO3, CL, H2AD

where:

JP = print flag = 1 for full print, 2 for short print, 0 for no print

K1 = concentration flag = 1 for ppm (mg/l)
2 for g-mole/l

This flag designates the units for the concentrations on line 3

JS = solids flag = 0 for no solids, 1 if solids might be present

TK = temperature of liquor, °K

PSO2 = partial pressure of SO_2 if specified by the user, atm

PCO2 = partial pressure of CO_2 if specified by the user, atm

SS1
SS2
SS3 } set these equal to unity (one)

IPH = pH flag = 0 if pH is calculated by the program
1 if pH is specified by the user
Do not use IPH = 1 unless JS = 0 (no solids)

PH = value of pH, if specified by user (IPH = 1)

CA, MG, NA, K, SO3, SO4, CO3, CL, H2AD = concentrations of total calcium, magnesium, sodium, potassium, sulfite, sulfate, carbonate, chloride, and adipic acid in ppm (K1 = 1) or g-mole/l (K1 = 2).

Notes: (1) Do not use solids (JS = 1) option unless PCO2 is specified by the user as a non-zero value.

(2) If PCO2 is specified, then the value of CO3 on line three should be zero.

(3) If PSO2 is specified, then the value of SO3 on line three should be zero.

When only the liquor gypsum saturation and the ionic imbalance are desired, the LIQ FORTRAN file is used. Data for this program is input through a LIQ DATA file. The format for this file is :

Case No., PH, CA, MG, NA, K, SO3, SO4, CL, H2AD

where:

CA, MG, NA, K, SO3, SO4, CL, H2AD = concentrations of total calcium, magnesium, sodium, potassium, sulfite, sulfate, chloride, and adipic acid in ppm.

K.1.3 Example Test Cases and Program Listings

Sample data files are listed below and the corresponding program output is presented on the following pages.

```
14.18.52 >p beq data

CASE NO. 1
1,2,1, 323,0,0.12,1,1,1,0,0
2. 0.1 0.02 0.02 0.5 0.5 0 0.2 0.02
CASE NO. 2
1,2,0, 323,0,0.12,1,1,1,1,5.0
0.01 0 1.0 0 0.1 0.4 0 0.05 0.06
CASE NO. 3
1,1,0, 323,0,0.12,1,1,1,1,4.60
3070 1300 110 150 1540 2510 0 5340 4090
```

```
13.27.47 >p liq data

1 4.60 3070 1300 110 150 1540 2510 5340 4090
2 5.05 2750  945  95 100 325 1950 5410  735
3 5.20  715 10465 195 150 735 31350 6870 0
```

```
13.27.27 >liq              ←—— EXECUTE PROGRAM
EXECUTION:
        1  130.      3.9
        2  113.      7.1
        3  123.      5.6

END OF DATA
```

Where for example 1, the gypsum saturation is 130 percent and the percent ionic imbalance is 3.9.

```
14.19.05 >beq          ←—— EXECUTE PROGRAM
EXECUTION:




                                           06/16/81 AT 14.19
    CASE NO. 1

                              BECHTEL MODIFIED RADIAN EQUILIBRIUM PROGRAM
INPUT DATA:
   K1    JS    TK       PPSO2        PPCO2       SSO3  SCO3  SSO4   IPH    PH
    2     1   323.0    .0           .1200        1.00  1.00  1.00     0   0.0

   CONCENTRATIONS, GMOL/LITER AND PPM(WT):
     CA      MG      NA       K       SO3      SO4      CO3       CL     H2AD
2.00000 0.10000 0.02000 0.02000 0.50000 0.50000 0.0      0.20000 0.02000
 80160.   2431.    460.    782.  40030.  48030.      0.   7090.   2920.

CALCULATED RESULTS:          CONCENTRATION
              COMPONENT      GMOL/LITER         ACTIVITY COEFFICIENT

              H+             0.6876E-06            0.8679
              OH-            0.1266E-06            0.7190
              H2CO3          0.2089E-02            1.0756
              HCO3-          0.2913E-02            0.6671
              CO3--          0.1107E-05            0.1980
              H2SO3          0.5361E-07            1.0756
              HSO3-          0.1137E-02            0.6671
              SO3--          0.2740E-03            0.1980
              HSO4-          0.4545E-06            0.7190
              SO4--          0.1848E-01            0.1440
              CA++           0.3407E-01            0.2433
              CAOH+          0.2923E-07            0.7190
              CAHCO3+        0.4873E-03            0.7190
              CACO3          0.3556E-05            1.0756
              CASO3          0.1411E-02            1.0756
              CASO4          0.5797E-02            1.0756
              MG++           0.8056E-01            0.2673
              MGOH+          0.1426E-05            0.7190
              MGHCO3+        0.6082E-03            0.7190
              MGCO3          0.1480E-04            1.0756
              MGSO3          0.1171E-02            1.0756
              MGSO4          0.1764E-01            1.0756
              NA+            0.3934E-01            0.7173
              NAOH           0.6428E-09            1.0756
              NAHCO3         0.2866E-04            1.0756
              NACO3-         0.1907E-06            0.7190
              NASO4-         0.6336E-03            0.7190
              CL-            0.2000E+00            0.6516
              CACO3 (S)      0.1005E+01            1.0000
              CASO3 (S)      0.4960E+00            1.0000
              CASO4 (S)      0.4574E+00            1.0000
              H2AD           0.5293E-05            1.0756
              HAD-           0.5045E-03            0.7190
              AD--           0.1350E-01            0.1440
              CAAD           0.5992E-02            1.0756

PH =  6.224        PPSO2 =  .1070E-06 ATM        CO2 =  1.010925 GMOL/L


PERCENT SULFATE SATURATION =  100.0         ( KSP = 0.2207E-04 )

TOTAL DISSOLVED SOLIDS =   20133. PPM

ANALYSIS OF SLURRY:          LIQUID                       SOLID
                             GMOL/LITER       PPM         GMOL/LITER        PPM
                    CA        0.4776E-01     1914.          0.1958E+01    78486.
                    MG        0.1000E+00     2431.          0.0               0.
                    NA        0.2000E-01      460.          0.0               0.
                    K         0.2000E-01      782.          0.0               0.
                    SO3       0.3993E-02      320.          0.4960E+00    39710.
                    SO4       0.4255E-01     4088.          0.4574E+00    43942.
                    CO3       0.6146E-02      369.          0.1005E+01    60297.
                    CL        0.2000E+00     7090.          0.0               0.
                    H2AD      0.2000E-01     2920.          0.0               0.
```

```
                                              06/16/81 AT 14.21
        CASE NO. 2
                                    BECHTEL MODIFIED RADIAN EQUILIBRIUM PROGRAM
    INPUT DATA:
       K1    JS     TK       PPSO2          PPCO2        SSO3  SCO3  SSO4   IPH    PH
        2     0   323.0    .0             .1200          1.00  1.00  1.00     1  5.00

       CONCENTRATIONS, GMOL/LITER AND PPM(WT):
         CA      MG      NA       K       SO3     SO4     CO3       CL    H2AD
    0.01000 0.0      1.00000 0.0      0.10000 0.40000 0.0       0.05000 0.06000
       401.      0.  22990.       0.   8006.  38424.       0.   1772.   8760.

    CALCULATED RESULTS:               CONCENTRATION
              COMPONENT               GMOL/LITER          ACTIVITY COEFFICIENT

              H+                      0.8116E-05              1.2322
              OH-                     0.6495E-08              0.8366
              H2CO3                   0.1794E-02              1.2527
              HCO3-                   0.1947E-03              0.5956
              CO3--                   0.6204E-08              0.1258
              H2SO3                   0.5896E-04              1.2527
              HSO3-                   0.9735E-01              0.5956
              SO3--                   0.1967E-02              0.1258
              HSO4-                   0.5253E-04              0.8366
              SO4--                   0.2948E+00              0.0725
              CA++                    0.3918E-02              0.2379
              CAOH+                   0.1686E-09              0.8366
              CAHCO3+                 0.2810E-05              0.8366
              CACO3                   0.1223E-08              1.2527
              CASO3                   0.6215E-03              1.2527
              CASO4                   0.4492E-02              1.2527
              NA+                     0.8993E+00              0.7225
              NAOH                    0.7585E-09              1.2527
              NAHCO3                  0.3383E-04              1.2527
              NACO3-                  0.1344E-07              0.8366
              NASO4-                  0.1006E+00              0.8366
              CL-                     0.5000E-01              0.5728
              H2AD                    0.2130E-02              1.2527
              HAD-                    0.1213E-01              0.8366
              AD--                    0.4478E-01              0.0725
              CAAD                    0.9657E-03              1.2527

     PH  =  5.000         PPSO2  =  .1371E-03 ATM       CO2  =  0.002025 GMOL/L

     PERCENT ERROR IN IONIC BALANCE  =   -3.6

     PERCENT SULFATE SATURATION  =   90.3          ( KSP  = 0.2207E-04 )

     TOTAL DISSOLVED SOLIDS  =   80475. PPM

     ANALYSIS OF SLURRY:              LIQUID                         SOLID
                                      GMOL/LITER        PPM          GMOL/LITER          PPM
                            CA        0.1000E-01       401.            0.0                0.
                            NA        0.1000E+01     22990.            0.0                0.
                            SO3       0.1000E+00      8006.            0.0                0.
                            SO4       0.4000E+00     38424.            0.0                0.
                            CO3       0.2025E-02       122.            0.0                0.
                            CL        0.5000E-01      1772.            0.0                0.
                            H2AD      0.6000E-01      8760.            0.0                0.
```

```
                                                06/16/81 AT 14.23
     CASE NO. 3

                                  BECHTEL MODIFIED RADIAN EQUILIBRIUM PROGRAM
INPUT DATA:
   K1    JS    TK      PPSO2         PPCO2        SSO3  SCO3  SSO4   IPH    PH
    1     0  323.0   .0            .1200          1.00  1.00  1.00     1  4.60

   CONCENTRATIONS, GMOL/LITER AND PPM(WT):
     CA      MG      NA       K      SO3     SO4      CO3       CL     H2AD
0.07660 0.05348 0.00478 0.00384 0.01924 0.02613 0.0       0.15063 0.02801
  3070.   1300.    110.    150.   1540.   2510.      0.    5340.   4090.

CALCULATED RESULTS:             CONCENTRATION
                COMPONENT       GMOL/LITER          ACTIVITY COEFFICIENT

                H+              0.2946E-04              0.8526
                OH-             0.3007E-08              0.7193
                H2CO3           0.2111E-02              1.0644
                HCO3-           0.6811E-04              0.6778
                CO3--           0.5862E-09              0.2110
                H2SO3           0.3632E-04              1.0644
                HSO3-           0.1783E-01              0.6778
                SO3--           0.9730E-04              0.2110
                HSO4-           0.1303E-04              0.7193
                SO4--           0.1150E-01              0.1577
                CA++            0.6214E-01              0.2518
                CAOH+           0.1310E-08              0.7193
                CAHCO3+         0.2184E-04              0.7193
                CACO3           0.3829E-08              1.0644
                CASO3           0.1018E-02              1.0644
                CASO4           0.7535E-02              1.0644
                MG++            0.4623E-01              0.2677
                MGOH+           0.1947E-07              0.7193
                MGHCO3+         0.8301E-05              0.7193
                MGCO3           0.4853E-08              1.0644
                MGSO3           0.2573E-03              1.0644
                MGSO4           0.6982E-02              1.0644
                NA+             0.8527E-02              0.7223
                NAOH            0.3368E-11              1.0644
                NAHCO3          0.1502E-06              1.0644
                NACO3-          0.2349E-10              0.7193
                NASO4-          0.9421E-04              0.7193
                CL-             0.1506E+00              0.6633
                H2AD            0.4875E-02              1.0644
                HAD-            0.1092E-01              0.7193
                AD--            0.6342E-02              0.1577
                CAAD            0.5879E-02              1.0644

PH =  4.600        PPSO2 =  .7174E-04 ATM        CO2 =  0.002209 GMOL/L

PERCENT ERROR IN IONIC BALANCE =     3.7

PERCENT SULFATE SATURATION =  128.6        ( KSP = 0.2207E-04 )

TOTAL DISSOLVED SOLIDS =   18243. PPM

ANALYSIS OF SLURRY:              LIQUID                      SOLID
                                 GMOL/LITER       PPM        GMOL/LITER          PPM
                     CA          0.7660E-01      3070.          0.0               0.
                     MG          0.5348E-01      1300.          0.0               0.
                     NA          0.4785E-02       110.          0.0               0.
                     K           0.3836E-02       150.          0.0               0.
                     SO3         0.1924E-01      1540.          0.0               0.
                     SO4         0.2613E-01      2510.          0.0               0.
                     CO3         0.2209E-02       133.          0.0               0.
                     CL          0.1506E+00      5340.          0.0               0.
                     H2AD        0.2801E-01      4090.          0.0               0.
```

K.2 PROGRAM LISTINGS

```
BQ2IT    FORTRAN  P ID=BECAQX    09.14.01  MONDAY 8 JUNE 1981          PAGE 1
   NATIONAL CSS, INC. (SUNNYVALE DATA CENTER)          SUNY

      SUBROUTINE BEQ (NOPR,JSS,IOPT,TK,X,CM,PP,SS,IPH,PH,FNA)
C*********************************************************************
C****** THIS ROUTINE DETERMINES AQUEOUS SOLUTION EQUILIBRIA FOR THE
C       SYSTEM SO2,CO2,SO3,N2O5,CA,MG,NA,CL, AND ADIPIC ACID.
C
C****** FOR JSS=1 AND SPECIFIED PPCO2, SOLIDS ARE ALSO DETERMINED.
C
C
C
C*********************************************************************
C
C                             COMPONENTS
C
C                             (1)    H+
C                             (2)    OH-
C                             (3)    H2CO3
C                             (4)    HCO3-
C                             (5)    CO3--
C                             (6)    H2SO3
C                             (7)    HSO3-
C                             (8)    SO3--
C                             (9)    HSO4-
C                             (10)   SO4--
C                             (11)   CA++
C                             (12)   CAOH+
C                             (13)   CAHCO3+
C                             (14)   CACO3
C                             (15)   CASO3
C                             (16)   CASO4
C                             (17)   MG++
C                             (18)   MGOH+
C                             (19)   MGHCO3+
C                             (20)   MGCO3
C                             (21)   MGSO3
C                             (22)   MGSO4
C                             (23)   NO3-
C                             (24)   CANO3+
C                             (25)   NA+
C                             (26)   NANO3
C                             (27)   NAOH
C                             (28)   NAHCO3
C                             (29)   NACO3-
C                             (30)   NASO4-
C                             (31)   CL-
C                             (32)   CACO3 (S)
C                             (33)   CASO3 (S)
C                             (34)   CASO4 (S)
C                             (35)   CA(OH)2 (S)
C                             (36)   MGCO3 (S)
C                             (37)   MG(OH)2 (S)
C                             (38)   H2AD
C                             (39)   HAD-
C                             (40)   AD--
C                             (41)   CAAD
C
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C                                                                       LIQ00560
C                                                                       LIQ00570
C                                                                       LIQ00580
C             EQUATIONS                                                 LIQ00590
C                                                                       LIQ00600
C             (1)    (H+)(OH-) = K(1)                                   LIQ00610
C                                                                       LIQ00620
C             (2)    (H2CO3) = PPCO2/K(2)                               LIQ00630
C                                                                       LIQ00640
C             (3)    (H+)(HCO3-) = (H2CO3)*K(3)                         LIQ00650
C                                                                       LIQ00660
C             (4)    (H+)(CO3--) = (HCO3-)*K(4)                         LIQ00670
C                                                                       LIQ00680
C             (5)    (H+)(HSO3-) = (H2SO3)*K(5)                         LIQ00690
C                                                                       LIQ00700
C             (6)    (H+)(SO3--) = (HSO3-)*K(6)                         LIQ00710
C                                                                       LIQ00720
C             (7)    (H+)(SO4--) = (HSO4-)*K(7)                         LIQ00730
C                                                                       LIQ00740
C             (8)    (CA++)(OH-) = (CAOH+)*K(8)                         LIQ00750
C                                                                       LIQ00760
C             (9)    (CA++)(HCO3-) = (CAHCO3+)*K(9)                     LIQ00770
C                                                                       LIQ00780
C             (10)   (CA++)(CO3--) = (CACO3)*K(10)                      LIQ00790
C                                                                       LIQ00800
C             (11)   (CA++)(SO3--) = (CASO3)*K(11)                      LIQ00810
C                                                                       LIQ00820
C             (12)   (CA++)(SO4--) = (CASO4)*K(12)                      LIQ00830
C                                                                       LIQ00840
C             (13)   (MG++)(OH-) = (MGOH+)*K(13)                        LIQ00850
C                                                                       LIQ00860
C             (14)   (MG++)(HCO3-) = (MGHCO3+)*K(14)                    LIQ00870
C                                                                       LIQ00880
C             (15)   (MG++)(CO3--) = (MGCO3)*K(15)                      LIQ00890
C                                                                       LIQ00900
C             (16)   (MG++)(SO3--) = (MGSO3)*K(16)                      LIQ00910
C                                                                       LIQ00920
C             (17)   (MG++)(SO4--) = (MGSO4)*K(17)                      LIQ00930
C                                                                       LIQ00940
C             (18)   SO2 MATERIAL BALANCE                               LIQ00950
C                                                                       LIQ00960
C             (19)   SO3 MATERIAL BALANCE                               LIQ00970
C                                                                       LIQ00980
C             (20)   CA MATERIAL BALANCE                                LIQ00990
C                                                                       LIQ01000
C             (21)   MG MATERIAL BALANCE                                LIQ01010
C                                                                       LIQ01020
C             (22)   CHARGE BALANCE                                     LIQ01030
C                                                                       LIQ01040
C             (23)   (H2SO3) = PPSO2/K(23)                              LIQ01050
C                                                                       LIQ01060
C             (24)   (CA++)(NO3-) = (CANO3+)*K(24)                      LIQ01070
C                                                                       LIQ01080
C             (25)   (NA+)(NO3-) = (NANO3)*K(25)                        LIQ01090
C                                                                       LIQ01100
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C               (26)  (NA+)(OH-) = (NAOH)*K(26)                         LIQ01110
C                                                                       LIQ01120
C               (27)  (NA+)(HCO3-) = (NAHCO3)*K(27)                     LIQ01130
C                                                                       LIQ01140
C               (28)  (NA+)(CO3--) = (NACO3-)*K(28)                     LIQ01150
C                                                                       LIQ01160
C               (29)  (NA+)(SO4--) = (NASO4-)*K(29)                     LIQ01170
C                                                                       LIQ01180
C               (30)  CO2 MATERIAL BALANCE                              LIQ01190
C                                                                       LIQ01200
C               (31)  NO2 MATERIAL BALANCE                              LIQ01210
C                                                                       LIQ01220
C               (32)  NA MATERIAL BALANCE                               LIQ01230
C                                                                       LIQ01240
C               (33)  (CL-) = CONSTANT                                  LIQ01250
C                                                                       LIQ01260
C               (34)  (CA++)(CO3--) L.E. K(34)                          LIQ01270
C                                                                       LIQ01280
C               (35)  (CA++)(SO3--) L.E. K(35)                          LIQ01290
C                                                                       LIQ01300
C               (36)  (CA++)(SO4--) L.E. K(36)                          LIQ01310
C                                                                       LIQ01320
C               (37)  (CA++)(OH-)**2 L.E. K(37)                         LIQ01330
C                                                                       LIQ01340
C               (38)  (MG++)(CO3--) L.E. K(38)                          LIQ01350
C                                                                       LIQ01360
C               (39)  (MG++)(OH-)**2 L.E. K(39)                         LIQ01370
C                                                                       LIQ01380
C               (40)  (H+)(HAD-) = (H2AD)*K(40)                         LIQ01390
C                                                                       LIQ01400
C               (41)  (H+)(AD--) = (HAD-)*K(41)                         LIQ01410
C                                                                       LIQ01420
C               (42)  (CA++)(AD--) = (CAAD)*K(42)                       LIQ01430
C                                                                       LIQ01440
C               (43)  AD MATERIAL BALANCE                               LIQ01450
C                                                                       LIQ01460
C                                                                       LIQ01470
C                                                                       LIQ01480
C                                                                       LIQ01490
C                                                                       LIQ01500
C                                                                       LIQ01510
C                                                                       LIQ01520
C                                                                       LIQ01530
C                                                                       LIQ01540
C                                                                       LIQ01550
C                                                                       LIQ01560
C                                                                       LIQ01570
C                                                                       LIQ01580
C                                                                       LIQ01590
C                                                                       LIQ01600
C                                                                       LIQ01610
C                                                                       LIQ01620
C                                                                       LIQ01630
C                                                                       LIQ01640
C                                                                       LIQ01650
```

```
C
C
C
      DIMENSION X(50),CM(10),PP(2),IFLAG(10),SS(3)
      COMMON/CEE/C1,C3,C5,C6,C7,F1,F3
      COMMON/GAMMA/GAM(50)
      COMMON/TEMP/AC,BC,CPK(2),CK(50)
      COMMON/COMP/LON
      COMMON/PRESS/PP1,PP2
      REAL K(50),LOW
      JS = JSS
    2 CONTINUE
      X(1) = 0.
      EPS = .00000001
      IF(JS.NE.JSS) PP(1) = PP1
      PP1 = PP(1)
      PP2 = PP(2)
      LON = 0
      SCASO3 = 1000.
      CM15 = CM(1)-CM(5)
      CM35 = CM(3)-CM(5)
      IF(IOPT.EQ.3.OR.IOPT.EQ.1) CM(1) = 0.
      IF(IOPT.EQ.2.OR.IOPT.EQ.3) CM(2) = 0.
      IF(CM(4).GT.EPS.OR.CM(7).GT.EPS.OR.CM(8).GT.EPS.OR.CM(9).GT.EPS)
     1 LON = 1
      IT = 30
      TOL = 0.01
      IF(JS.NE.0) TOL = 0.0001
      IF(IPH.EQ.1) GO TO 5
      ACID = CM(1)+CM(3)+0.5*CM(4)+0.5*CM(8)-CM(5)-CM(6)-0.5*CM(7)
      IF(ACID.LE.0.) X(1) = 1.E-6
      IF(ACID.GT.0.) X(1) = 1.E-4
      IF(LON.EQ.1.AND.CM(7).GT.(CM(5)+CM(6)).AND.ACID.LT.0.) X(1) =
     1 1.E-8
      IF(PP(1).GT..0001) X(1) = 1.E-4
    5 CONTINUE
      IF(JS.NE.JSS) GO TO 30
      KOUNT = 0
      KN = 0
      KP = 0
      DO 10 I=1,9
      IF (I.EQ.8) GO TO 10
      IFLAG(I) = 0
      IF(CM(I).LT.EPS) GO TO 10
      IFLAG(I) = 1
      KOUNT = KOUNT+1
      IF(I.GT.4.AND.I.LT.9) KP = KP+1
      IF(I.LT.5.OR.I.EQ.9) KN = KN+1
   10 CONTINUE
      IF(KP.EQ.0.OR.KN.EQ.0) IT = 1
      IS5 = 1
      IF(JS.EQ.0.OR.IFLAG(5).EQ.0) IS5 = 0
C****** CALCULATE TEMPERATURE-DEPENDENT CONSTANTS
      CALL TCON(JS,TK)
C
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C****** INITIAL ESTIMATES FOR CONCENTRATIONS TO DETERMINE
C       ACTIVITY COEFFICIENTS
   30 CONTINUE
      DO 40 I=2,37
      X(I) = 0.
   40 CONTINUE
      X(7) = CM(1)
      X(10) = CM(3)
      X(11) = CM(5)
      X(17) = CM(6)
      X(23) = CM(4)
      X(25) = CM(7)
      X(31) = CM(8)
      X(39) = CM(9)
C****** OUTER LOOP FOR CONVERGENCE OF ACTIVITY COEFFICIENTS
      ITGAM = 2
      IF(JS.NE.0) ITGAM = 5
      DO 1000 JJ=1,ITGAM
      ITO = 0
      HI = 20.
      LOW = -1.
      CALL KCALC(JJ,JS,X,SS,K)
      IF(IPH.EQ.0) PH = -ALOG10(X(1)*GAM(1))
      IF(IPH.EQ.1) X(1) = 1./GAM(1)/(10.**PH)
      IF(IFLAG(2).EQ.0) X(3) = PP(2)/K(2)
      IF(IFLAG(1).EQ.0) X(6) = PP(1)/K(23)
C****** INNER LOOP FOR CONVERGENCE OF PH
  100 CONTINUE
      X(2) = K(1)/X(1)
      IF(IFLAG(1).EQ.1) GO TO 102
      X(7) = K(5)*X(6)/X(1)
      X(8) = K(6)*X(7)/X(1)
      GO TO 105
  102 CONTINUE
      X7X8 = X(1)/K(6)
      X6X8 = X7X8*X(1)/K(5)
      C1 = 1.+X7X8+X6X8
  105 CONTINUE
      IF(IFLAG(2).EQ.1) GO TO 110
      X(4) = K(3)*X(3)/X(1)
      X(5) = K(4)*X(4)/X(1)
      GO TO 115
  110 CONTINUE
      X4X5 = X(1)/K(4)
      X3X5 = X(1)*X(1)/K(4)/K(3)
      C2 = 1.+X4X5+X3X5
  115 CONTINUE
      IF(IFLAG(3).EQ.0) GO TO 120
      X9X10 = X(1)/K(7)
      C3 = 1.+X9X10
  120 CONTINUE
      IF(IFLAG(5).EQ.0) GO TO 130
      X12X11 = X(2)/K(8)
      IF(IFLAG(2).EQ.1) GO TO 125
      X13X11 = X(4)/K(9)
      X14X11 = X(5)/K(10)                                               LIQ02760
      C5 = 1.+X12X11+X13X11+X14X11                                      LIQ02770
      GO TO 130                                                         LIQ02780
  125 CONTINUE                                                          LIQ02790
      C5 = 1.+X12X11                                                    LIQ02800
  130 CONTINUE                                                          LIQ02810
      IF(IFLAG(6).EQ.0) GO TO 140                                       LIQ02820
      X18X17 = X(2)/K(13)                                               LIQ02830
      IF(IFLAG(2).EQ.1) GO TO 135                                       LIQ02840
      X19X17 = X(4)/K(14)                                               LIQ02850
      X20X17 = X(5)/K(15)                                               LIQ02860
      C6 = 1.+X18X17+X19X17+X20X17                                      LIQ02870
      GO TO 140                                                         LIQ02880
  135 CONTINUE                                                          LIQ02890
      C6 = 1.+X18X17                                                    LIQ02900
  140 CONTINUE                                                          LIQ02910
      IF(IFLAG(7).EQ.0) GO TO 150                                       LIQ02920
      X27X25 = X(2)/K(26)                                               LIQ02930
      IF(IFLAG(2).EQ.1) GO TO 145                                       LIQ02940
      X28X25 = X(4)/K(27)                                               LIQ02950
      X29X25 = X(5)/K(28)                                               LIQ02960
      C7 = 1.+X27X25+X28X25+X29X25                                      LIQ02970
      GO TO 150                                                         LIQ02980
  145 CONTINUE                                                          LIQ02990
      C7 = 1.+X27X25                                                    LIQ03000
  150 CONTINUE                                                          LIQ03010
      IF (IFLAG(9).EQ.0) GO TO 155                                      LIQ03020
      X39X40 = X(1)/K(41)                                               LIQ03030
      X38X40 = X39X40*X(1)/K(40)                                        LIQ03040
      C9 = 1.+X39X40+X38X40                                             LIQ03050
  155 CONTINUE                                                          LIQ03060
      IF(JS.EQ.0) GO TO 195                                             LIQ03070
      IF(IFLAG(5).EQ.0.OR.JS.GE.2) GO TO 180                            LIQ03080
      SCAOH2 = K(37)/X(2)/X(2)                                          LIQ03090
      SCACO3 = K(34)/X(5)                                               LIQ03100
      IF(PP(1).GT.1.E-20) SCASO3 = K(35)/X(8)                           LIQ03110
      IF(SCACO3.LT.SCASO3.AND.SCACO3.LT.SCAOH2) GO TO 160               LIQ03120
      IF(SCAOH2.LT.SCASO3) GO TO 170                                    LIQ03130
      SOL5 = SCASO3                                                     LIQ03140
      ISOL5 = 1                                                         LIQ03150
      GO TO 180                                                         LIQ03160
  160 CONTINUE                                                          LIQ03170
      SOL5 = SCACO3                                                     LIQ03180
      ISOL5 = 2                                                         LIQ03190
      GO TO 180                                                         LIQ03200
  170 CONTINUE                                                          LIQ03210
      SOL5 = SCAOH2                                                     LIQ03220
      ISOL5 = 3                                                         LIQ03230
  180 CONTINUE                                                          LIQ03240
      IF(IFLAG(6).EQ.0) GO TO 195                                       LIQ03250
      SMGOH2 = K(39)/X(2)/X(2)                                          LIQ03260
      SMGCO3 = K(38)/X(5)                                               LIQ03270
      IF(SMGOH2.LT.SMGCO3) GO TO 190                                    LIQ03280
      SOL6 = SMGCO3                                                     LIQ03290
      ISOL6 = 2                                                         LIQ03300
      GO TO 195                                                         LIQ03310
  190 CONTINUE                                                          LIQ03320
      SOL6 = SMGOH2                                                     LIQ03330
      ISOL6 = 3                                                         LIQ03340
  195 CONTINUE                                                          LIQ03350
      IF(JS.LT.2) GO TO 199                                             LIQ03360
      IF(JS.EQ.3) GO TO 196                                             LIQ03370
      IF(JS.EQ.4) GO TO 197                                             LIQ03380
      CALL CASO3 (IFLAG,K,X,CM,PP,SOL6)                                 LIQ03390
      GO TO 300                                                         LIQ03400
  196 CONTINUE                                                          LIQ03410
      CALL CASO4 (IFLAG,K,X,CM,PP,SOL6)                                 LIQ03420
      GO TO 300                                                         LIQ03430
  197 CONTINUE                                                          LIQ03440
      CALL CASOX (IFLAG,K,X,CM,PP,SOL6)                                 LIQ03450
      GO TO 300                                                         LIQ03460
  199 CONTINUE                                                          LIQ03470
C****** CALCULATE BASE IONS (SO3--,CO3--,SO4--,NO3-,CA++,MG++,NA+)       LIQ03480
      IF(IFLAG(1).EQ.1) X(8) = 0.                                       LIQ03490
      IF(IFLAG(2).EQ.1) X(5) = 0.                                       LIQ03500
      X(10) = 0.                                                        LIQ03510
      X(23) = 0.                                                        LIQ03520
      X(40) = 0.                                                        LIQ03530
      F51 = 0.                                                          LIQ03540
      F53 = 0.                                                          LIQ03550
      C5S = C5                                                          LIQ03560
      C6S = C6                                                          LIQ03570
      C7S = C7                                                          LIQ03580
      DO 255 I=1,IT                                                     LIQ03590
      IF(IFLAG(2).EQ.0) GO TO 200                                       LIQ03600
      X514 = X(5)*X4X5                                                  LIQ03610
      IF(IFLAG(5).EQ.1) C5 = C5S+X(5)/K(10)+X514/K(9)                   LIQ03620
      IF(IFLAG(6).EQ.1) C6 = C6S+X(5)/K(15)+X514/K(14)                  LIQ03630
      IF(IFLAG(7).EQ.1) C7 = C7S+X(5)/K(28)+X514/K(27)                  LIQ03640
  200 CONTINUE                                                          LIQ03650
      IF(IFLAG(5).EQ.0) GO TO 210                                       LIQ03660
      X(11) = CM(5)/(C5+X(8)/K(11)+X(10)/K(12)+X(23)/K(24)+X(40)/K(42)  LIQ03670
     1 +F51+F53)                                                        LIQ03680
      IF(JS.NE.0) X(11) = AMIN1(X(11),SOL5)                             LIQ03690
  210 CONTINUE                                                          LIQ03700
      IF(IFLAG(6).EQ.0) GO TO 220                                       LIQ03710
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))                         LIQ03720
      IF(JS.NE.0) X(17) = AMIN1(X(17),SOL6)                             LIQ03730
  220 CONTINUE                                                          LIQ03740
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))      LIQ03750
      IF(IFLAG(1).EQ.0) GO TO 230                                       LIQ03760
      F1 = C1+X(11)/K(11)+X(17)/K(16)                                   LIQ03770
      X(8) = CM(1)/F1                                                   LIQ03780
      IF (IS5.EQ.0) GO TO 230                                           LIQ03790
      X(8) = AMIN1(X(8),K(35)/X(11))                                    LIQ03800
      X(8) = AMAX1(X(8),CM15/F1)                                        LIQ03810
      F51 = X(8)*(CM(1)-X(8)*F1)/K(35)                                  LIQ03820
  230 CONTINUE                                                          LIQ03830
      IF(IFLAG(2).EQ.1) X(5) = CM(2)/(C2+X(11)/K(10)+X(11)*X4X5/K(9)    LIQ03840
     1 +X(17)/K(15)+X(17)*X4X5/K(14)+X(25)/K(28)+X(25)*X4X5/K(27))      LIQ03850
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      IF(IFLAG(3).EQ.0) GO TO 240                                       LIQ03860
      F3 = C3+X(11)/K(12)+X(17)/K(17)+X(25)/K(29)                       LIQ03870
      X(10) = CM(3)/F3                                                  LIQ03880
      IF(IS5.EQ.0) GO TO 240                                            LIQ03890
      X(10) = AMIN1(X(10),K(36)/X(11))                                  LIQ03900
      X(10) = AMAX1(X(10),CM35/F3)                                      LIQ03910
      F53 = X(10)*(CM(3)-X(10)*F3)/K(36)                                LIQ03920
  240 CONTINUE                                                          LIQ03930
      IF(IFLAG(4).EQ.1) X(23) = CM(4)/(1.+X(11)/K(24)+X(25)/K(25))      LIQ03940
      IF (IFLAG(9).EQ.1) X(40) = CM(9)/(C9+X(11)/K(42))                 LIQ03950
  255 CONTINUE                                                          LIQ03960
  256 CONTINUE                                                          LIQ03970
C****** CALCULATE ALL UNDETERMINED IONS                                 LIQ03980
  300 CONTINUE                                                          LIQ03990
      IF(IFLAG(1).EQ.0) GO TO 310                                       LIQ04000
      X(7) = X(8)*X7X8                                                  LIQ04010
  310 CONTINUE                                                          LIQ04020
      IF(IFLAG(2).EQ.0) GO TO 315                                       LIQ04030
      X(4) = X(5)*X4X5                                                  LIQ04040
  315 CONTINUE                                                          LIQ04050
      IF(IFLAG(3).EQ.0) GO TO 320                                       LIQ04060
      X(9) = X(10)*X9X10                                                LIQ04070
  320 CONTINUE                                                          LIQ04080
      IF(IFLAG(5).EQ.0) GO TO 330                                       LIQ04090
      X(12) = X(11)*X12X11                                              LIQ04100
      X(24) = X(11)*X(23)/K(24)                                         LIQ04110
      X(13) = X(11)*X(4)/K(9)                                           LIQ04120
  330 CONTINUE                                                          LIQ04130
      IF(IFLAG(6).EQ.0) GO TO 340                                       LIQ04140
      X(18) = X(17)*X18X17                                              LIQ04150
      X(19) = X(17)*X(4)/K(14)                                          LIQ04160
  340 CONTINUE                                                          LIQ04170
      IF(IFLAG(7).EQ.0) GO TO 342                                       LIQ04180
      X(29) = X(25)*X(5)/K(28)                                          LIQ04190
      X(30) = X(25)*X(10)/K(29)                                         LIQ04200
  342 CONTINUE                                                          LIQ04210
      IF (IFLAG(9).EQ.0) GO TO 344                                      LIQ04220
      X(39) = X(40)*X39X40                                              LIQ04230
  344 CONTINUE                                                          LIQ04240
      IF(IPH.EQ.1) GO TO 500                                            LIQ04250
C****** CALCULATE NEW VALUE OF (H+)                                     LIQ04260
      PHIS = PHI                                                        LIQ04270
      PHI = 2.*(X(17)+X(11)-X(5)-X(8)-X(10)-X(40))+X(1)+X(12)+X(13)+    LIQ04280
     1 X(18)+X(19)+X(24)+X(25)-X(2)-X(4)-X(7)-X(9)-X(23)-X(29)-X(30)    LIQ04290
     2 -X(31)-X(39)                                                     LIQ04300
      ITO = ITO+1                                                       LIQ04310
      IF(JJ.GT.1.AND.ITO.EQ.1.AND.ABS(PHI).LT.2.*ABS(PHIS)) GO TO 500   LIQ04320
      IF(PHI.LT.0.) GO TO 360                                           LIQ04330
      LOW = PH                                                          LIQ04340
      IF(HI.LT.10.) GO TO 350                                           LIQ04350
      PH = PH+1.                                                        LIQ04360
      X(1) = X(1)/10.                                                   LIQ04370
      GO TO 100                                                         LIQ04380
  350 CONTINUE                                                          LIQ04390
      IF((HI-LOW).LT.TOL) GO TO 500                                     LIQ04400
      PH = (HI+LOW)/2.                                                  LIQ04410
      X(1) = 1./GAM(1)/(10.**PH)                                        LIQ04420
      GO TO 100                                                         LIQ04430
  360 CONTINUE                                                          LIQ04440
      HI = PH                                                           LIQ04450
      IF(LOW.GT.0.) GO TO 350                                           LIQ04460
      PH = PH-1.                                                        LIQ04470
      X(1) = X(1)*10.                                                   LIQ04480
      GO TO 100                                                         LIQ04490
  500 CONTINUE                                                          LIQ04500
 1000 CONTINUE                                                          LIQ04510
C****** ITERATIVE CALCULATION COMPLETE                                   LIQ04520
C                                                                       LIQ04530
C****** CALCULATE NEUTRAL MOLECULES                                      LIQ04540
      IF(IFLAG(1).EQ.0) GO TO 520                                       LIQ04550
      X(6) =    X(8)*X6X8                                               LIQ04560
      PP(1) = X(6)*K(23)                                                LIQ04570
  520 CONTINUE                                                          LIQ04580
      IF(IFLAG(2).EQ.0) GO TO 540                                       LIQ04590
      X(3) = X(5)*X3X5                                                  LIQ04600
      PP(2) = X(3)*K(2)                                                 LIQ04610
  540 CONTINUE                                                          LIQ04620
      X(14) = X(11)*X(5)/K(10)                                          LIQ04630
      X(15) = X(11)*X(8)/K(11)                                          LIQ04640
      X(16) = X(11)*X(10)/K(12)                                         LIQ04650
      X(20) = X(17)*X(5)/K(15)                                          LIQ04660
      X(21) = X(17)*X(8)/K(16)                                          LIQ04670
      X(22) = X(17)*X(10)/K(17)                                         LIQ04680
      X(26) = X(25)*X(23)/K(25)                                         LIQ04690
      X(27) = X(25)*X27X25                                              LIQ04700
      X(28) = X(25)*X(4)/K(27)                                          LIQ04710
      X(38) = X(40)*X38X40                                              LIQ04720
      X(41) = X(11)*X(40)/K(42)                                         LIQ04730
      IF(JS.EQ.0) GO TO 1010                                            LIQ04740
C****** CALCULATE SOLIDS                                                LIQ04750
      EPS1 = 1.E-6                                                      LIQ04760
      IF(IFLAG(5).EQ.0) GO TO 1001                                      LIQ04770
      IF(JS.EQ.3) GO TO 600                                             LIQ04780
      IF(IFLAG(1).EQ.1) X(33) = CM(1)-X(8)*F1                           LIQ04790
      IF(JS.EQ.2) GO TO 1001                                            LIQ04800
  600 CONTINUE                                                          LIQ04810
      IF(IFLAG(3).EQ.1) X(34) = CM(3)-X(10)*F3                          LIQ04820
      IF(JS.NE.1) GO TO 1001                                            LIQ04830
      F5 = C5+X(8)/K(11)+X(10)/K(12)+X(23)/K(24)                        LIQ04840
      IF(ISOL5.EQ.1) X(33) = CM(5)-X(34)-X(11)*F5                       LIQ04850
      IF(ISOL5.EQ.2) X(32) = CM(5)-X(33)-X(34)-X(11)*F5                 LIQ04860
      IF(ISOL5.EQ.3) X(35) = CM(5)-X(33)-X(34)-X(11)*F5                 LIQ04870
      IF(X(32).GT.EPS1.OR.X(35).GT.EPS1) GO TO 1001                     LIQ04880
      IF(X(33).GT.EPS1) GO TO 650                                       LIQ04890
      IF(X(34).LT.EPS1) GO TO 1001                                      LIQ04900
      JS = 3                                                            LIQ04910
      GO TO 2                                                           LIQ04920
  650 CONTINUE                                                          LIQ04930
      IF(ISOL5.EQ.1) GO TO 1001                                         LIQ04940
      IF(X(34).LT.EPS1) JS=2                                            LIQ04950
      IF(X(34).GT.EPS1) JS=4
      GO TO 2
 1001 CONTINUE
      IF(IFLAG(6).EQ.0) GO TO 1002
      F6 = C6+X(8)/K(16)+X(10)/K(17)
      IF(ISOL6.EQ.2) X(36) = CM(6)-X(17)*F6
      IF(ISOL6.EQ.3) X(37) = CM(6)-X(17)*F6
 1002 CONTINUE
      DO 1005 I=32,37
      IF(X(I).LT.EPS1) X(I) = 0.
 1005 CONTINUE
 1010 CONTINUE
      SS(1) = X(8) * X(11) / K(35)
      SS(3) = X(10) * X(11) / K(36)
C****** WRITE OUTPUT
      IP = NOPR
      IF(IP.NE.0)CALL BEQPRT(NOPR,IOPT,IFLAG,TK,X,CM,PP,SS,IPH,PH,FNA)
      RETURN
      END
      SUBROUTINE BEQPRT (NOPR,IOPT,IFLAG,TK,X,CM,PP,SS,IPH,PH,FNA)
C*****************************************************************
C****** THIS ROUTINE WRITES OUTPUT FOR SLURRY EQUILIBRIA
C       DETERMINED BY SUBROUTINE BEQ.
C
C*****************************************************************
      DIMENSION X(50),CM(10),PP(2),IFLAG(10),ILA(9),CML(9),CMS(9)
      DIMENSION IC(41), SS(3), CWL(9), CWS(9)
      COMMON/GAMMA/GAM(50)
      COMMON/TEMP/AC,BC,CPK(2),CK(50)
      COMMON /ID/ IDENT(20), CCM(10), CW(10)
      COMMON /INPUT/ PPSO2, PPCO2, SS1,SS2, SS3, KK1, JJS, PPH
      REAL*8 CMP(10) /'     CA','     MG','     NA', '      K',
     1 '    SO3','    SO4','    CO3','     CL','   H2AD',' '/
      REAL*8 LB(82)
      REAL MW(9)/40.08,24.31,22.99,39.10,80.06,96.06,60.01,35.45,146./
C
      DATA  LB/6HH+    ,6H      ,6HOH-   ,6H      ,6HH2CO3 ,6H      ,
     1 6HHCO3- ,6H      ,6HCO3-- ,6H      ,6HH2SO3 ,6H      ,6HHSO3- ,
     2 6H      ,6HSO3-- ,6H      ,6HHSO4- ,6H      ,6HSO4-- ,6H      ,
     3 6HCA++  ,6H      ,6HCAOH+ ,6H      ,6HCAHCO3,6H+     ,6HCACO3 ,
     4 6H      ,6HCASO3 ,6H      ,6HCASO4 ,6H      ,6HMG++  ,6H      ,
     5 6HMGOH+ ,6H      ,6HMGHCO3,6H+     ,6HMGCO3 ,6H      ,6HMGSO3 ,
     6 6H      ,6HMGSO4 ,6H      ,6HNO3-  ,6H      ,6HCANO3+,6H      ,
     7 6HNA+   ,6H      ,6HNANO3 ,6H      ,6HNAOH  ,6H      ,6HNAHCO3,
     8 6H      ,6HNACO3-,6H      ,6HNASO4-,6H      ,6HCL-   ,6H      ,
     9 6HCACO3 ,6H(S)   ,6HCASO3 ,6H(S)   ,6HCASO4 ,6H(S)   ,6HCA(OH),
     1 6H2 (S) ,6HMGCO3 ,6H(S)   ,6HMG(OH),6H2 (S) ,6HH2AD  ,6H      ,
     2 6HHAD-  ,6H      ,6HAD--  ,6H      ,6HCAAD  ,6H      /
C
C
      REAL*8 ILA /'CA','MG','NA','K','SO3','SO4','CO3','CL','H2AD'/
C
      DATA  IC/1,2,3,4,5,3,4,5,2,6,7,2,2,3,3,3,8,2,2,3,3,3,9,
     1 2,10,3,3,3,2,2,11,12,12,12,12,12,12,3,2,6,3/
C
      IP = NOPR
      PP1 = PP(1)
      PP2 = PP(2)
      WRITE(6,100)
  100 FORMAT(1H0,32X,'BECHTEL MODIFIED RADIAN EQUILIBRIUM PROGRAM'/
     1 1H , 'INPUT DATA:' )
      WRITE (6,150) KK1, JJS, TK, PPSO2, PPCO2, SS1,SS2, SS3, IPH, PPH
150   FORMAT(1H , 3X, 'K1', 4X, 'JS', 4X, 'TK', 6X, 'PPSO2', 8X,'PPCO2',
     1 7X, 'SSO3', 2X,'SCO3',2X, 'SSO4', 3X, 'IPH', 4X, 'PH' /
     2 1H , 1X, I4,2X,I4,2X, F6.1,2X, G10.4,2X, G10.4,5X,F4.2,2X,F4.2,2
     3 X,F4.2,
     4 3X, I3, 1X, F5.2 )
      WRITE (6,160) (CMP(I), I=1,9)
160   FORMAT( 1H0, 3X,'CONCENTRATIONS, GMOL/LITER AND PPM(WT):' /
     1 1H ,8(A7,1X),A7)
      WRITE (6,170) (CCM(I), I=1,9)
170   FORMAT( 1H , 8(F7.5, 1X), F7.5)
      WRITE (6,180) (CW(I), I=1,9)
  180 FORMAT(1H ,8(F7.0,1X),F7.0)
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      IF(IFLAG(1).EQ.0) CM1 = X(6)+X(7)+X(8)+X(15)+X(21)+X(33)
      IF(IFLAG(2).EQ.0) CM2 = X(3)+X(4)+X(5)+X(13)+X(14)+X(19)+X(20)
     1 +X(28)+X(29)+X(32)+X(36)
      IF(IP.NE.1) GO TO 1220
      WRITE(6,1100)
 1100 FORMAT( / 1H ,, 'CALCULATED RESULTS:', 12X, 'CONCENTRATION' /
     1       1H ,14X,'COMPONENT',8X,'GMOL/LITER',  10X,'ACTIVITY COEFFIC
     2IENT'/)
      DO 1300 I=1,41
      IF(X(I).LE.0.) GO TO 1300
      IS = 2*I-1
      IG = IC(I)
      WRITE(6,1200) LB(IS),LB(IS+1),X(I),GAM(IG)
 1300 CONTINUE
 1200 FORMAT(15X,A6,A6,E15.4,13X,F7.4)
      GO TO 1304
 1220 CONTINUE
      IF(IOPT.EQ.2.OR.IOPT.EQ.3) GO TO 1260
      WRITE(6,1240) PH,PP2
 1240 FORMAT(/1H ,'PH = ',F6.3,8X,'PPCO2 = ',G10.4,' ATM'/)
      GO TO 2300
 1260 CONTINUE
      WRITE(6,1280) PH,CM2
 1280 FORMAT(/1H ,'PH = ',F6.3,8X,'CO2 = ',F9.6,' GMOL/L'/)
      GO TO 2300
 1304 CONTINUE
      IF(IOPT.EQ.1) GO TO 1330
      IF(IOPT.EQ.2) GO TO 1350
      IF(IOPT.EQ.3) GO TO 2100
      WRITE(6,1310) PH,PP1,PP2
 1310 FORMAT(/1H ,'PH = ',F6.3,8X,'PPSO2 = ',G10.4,' ATM',8X,'PPCO2 = ',
     1 G10.4, ' ATM'/)
      GO TO 2300
 1330 CONTINUE
      WRITE(6,1340) PH,CM1,PP2
 1340 FORMAT(/1H ,'PH = ',F6.3,8X,'SO2 = ',F9.6,' GMOL/L',8X,'PPCO2 = ',
     1 G10.4, ' ATM'/)
      GO TO 2300
 1350 CONTINUE
      WRITE(6,1400) PH,PP1,CM2
 1400 FORMAT(/1H ,'PH = ',F6.3,8X,'PPSO2 = ',G10.4,' ATM',8X,'CO2 = ',
     1 F9.6, ' GMOL/L' /)
      GO TO 2300
 2100 CONTINUE
      WRITE(6,2200) PH,CM1,CM2
 2200 FORMAT(/1H ,'PH = ',F6.3,8X,'SO2 = ',F9.6,' GMOL/L',8X,'CO2 = ',
     1 F9.6, ' GMOL/L'/)
 2300 CONTINUE
      IF(IPH.EQ.0) GO TO 2380
      DEL = 2.*(X(11)+X(17))+X(1)+X(12)+X(13)+X(18)+X(19)+X(24)+X(25)
     1 -2.*(X(5)+X(8)+X(10)+X(40))-(X(2)+X(4)+X(7)+X(9)+X(23)+X(29)
     3 +X(30)+X(31)+X(39))
      ANF = 2.*(CM(5)+CM(6))+CM(7)
      PCTE = 100.*DEL/ANF
      WRITE(6,2360) PCTE
 2360 FORMAT( 1H ,*PERCENT ERROR IN IONIC BALANCE = *,F6.1)               LPR01110
 2380 CONTINUE                                                             LPR01120
      SS(3) = 100. * SS(3)                                                 LPR01130
      SS(1) = 100. * SS(1)                                                 LPR01140
      IF(IP.EQ.1) GO TO 2395                                               LPR01150
      WRITE(6,2385) SS(3)                                                  LPR01160
 2385 FORMAT(1H0,*PERCENT SULFATE SATURATION = *,F6.1)                     LPR01170
      GO TO 2398                                                           LPR01180
 2395 CONTINUE                                                             LPR01190
      WRITE (6, 2390) SS(3), CK(26)                                        LPR01200
 2390 FORMAT(1H0, *PERCENT SULFATE SATURATION = *, F6.1, 8X, *( KSP = *    LPR01210
     1 ,E10.4, * )* )                                                      LPR01220
 2398 CONTINUE                                                             LPR01230
      DO 2399 I=1,8                                                        LPR01240
      CML(I) = 0.                                                          LPR01250
      CMS(I) = 0.                                                          LPR01260
 2399 CONTINUE                                                             LPR01270
      EPS = 1.E-6                                                          LPR01280
      CML(1) = X(11)+X(12)+X(13)+X(14)+X(15)+X(16)+X(24)+X(41)             LPR01290
      CMS(1) = X(32)+X(33)+X(34)+X(35)                                     LPR01300
      CML(2) = X(17)+X(18)+X(19)+X(20)+X(21)+X(22)                         LPR01310
      CMS(2) = X(36)+X(37)                                                 LPR01320
      SUMX = X(25)+X(26)+X(27)+X(28)+X(29)+X(30)                           LPR01330
      CML(3) = FNA*SUMX                                                    LPR01340
      CML(4) = (1.-FNA)*SUMX                                               LPR01350
      CML(5) = X(6)+X(7)+X(8)+X(15)+X(21)                                  LPR01360
      CMS(5) = X(33)                                                       LPR01370
      CML(6) = X(9)+X(10)+X(16)+X(22)+X(30)                                LPR01380
      CMS(6) = X(34)                                                       LPR01390
      CML(7) = X(3)+X(4)+X(5)+X(13)+X(14)+X(19)+X(20)+X(28)+X(29)          LPR01400
      CMS(7) = X(32)+X(36)                                                 LPR01410
      CML(8) = X(31)                                                       LPR01420
      CML(9) = X(38)+X(39)+X(40)+X(41)                                     LPR01430
      CMLTOT = 0.                                                          LPR01440
      CMSTOT = 0.                                                          LPR01450
      CVLTOT = 0.                                                          LPR01460
      CVSTOT = 0.                                                          LPR01470
      DO 2410 I=1,9                                                        LPR01480
      CMLTOT = CMLTOT + CML(I)                                             LPR01490
      CMSTOT = CMSTOT + CMS(I)                                             LPR01500
      CWL(I) = 1000. * CML(I) * MW(I)                                      LPR01510
      CWS(I) = 1000. * CMS(I) * MW(I)                                      LPR01520
      CWLTOT = CWLTOT + CWL(I)                                             LPR01530
      CWSTOT = CWSTOT + CWS(I)                                             LPR01540
 2410 CONTINUE                                                             LPR01550
      CWTOT = 0.                                                           LPR01560
      IF(IOPT.GT.1) CW(7) = CM2*1000.*MW(7)                                LPR01570
      IF(IOPT.EQ.1.OR.IOPT.EQ.3) CW(5) = CM1*1000.*MW(5)                   LPR01580
      DO 2420  I=1,9                                                       LPR01590
 2420 CWTOT = CWTOT + CW(I)                                                LPR01600
      TDS = CWTOT - CWSTOT                                                 LPR01610
      WRITE (6,2450) TDS                                                   LPR01620
 2450 FORMAT(1H0, *TOTAL DISSOLVED SOLIDS = *, F8.0, * PPM*)               LPR01630
      IF(IP.NE.1) GO TO 2600                                               LPR01640
      WRITE(6,2400)                                                        LPR01650
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2400  FORMAT(1H0, *ANALYSIS OF SLURRY:*, 11X, *LIQUID*, 19X,            LPR01660
     1 *SOLID* /                                                        LPR01670
     2 1H , 30X, *GMOL/LITER*, 7X, *PPM*, 5X, *GMOL/LITER*, 10X, *PPM*) LPR01680
      DO 2440 I=1,9                                                     LPR01690
      IF(CML(I).LT.1.E-20.AND.CMS(I).LT.1.E-20) GO TO 2440              LPR01700
      WRITE (6,2500) ILA(I), CML(I), CWL(I), CMS(I), CWS(I)             LPR01710
 2440 CONTINUE                                                          LPR01720
 2500 FORMAT(1H , 21X, A8, E12.4, F10.0, 5X, E12.4, F10.0)              LPR01730
 2600 CONTINUE                                                          LPR01740
      RETURN                                                            LPR01750
      END                                                               LPR01760
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  NATIONAL CSS, INC. (SUNNYVALE DATA CENTER)          SUNY

      DIMENSION X(50),CM(10),PP(2),SS(3),XMW(10),SSOUT(200)
      REAL IIB(200)
      INTEGER CASE(200)
      COMMON/ID/IDENT(20),CCM(10),CW(10)
      COMMON/INPUT/PPSO2,PPCO2,SS1,SS3,KK1,JJS,PPH
      DATA  XMW/40.,24.3,23.,39.,80.,96.,35.5,146.,0.,0./
      IOUT = 0
  100 CONTINUE
      READ (5,120,END=300) XCASE,PH,(CCM(I),I=1,8)
      IOUT = IOUT+1
      IF (IOUT.GT.200) GO TO 300
      CASE(IOUT) = XCASE
  120 FORMAT (10G99.0)
      PP(1) = 0.
      PP(2) = 0.
      SS(1) = 1.
      SS(2) = 1.
      SS(3) = 1.
      IPH = 1
      DO 200 I=1,8
      CW(I) = CCM(I)
      CCM(I) = 0.001*CCM(I)/XMW(I)
  200 CONTINUE
      CM(1) = CCM(5)
      CM(2) = 0.
      CM(3) = CCM(6)
      CM(4) = 0.
      CM(5) = CCM(1)
      CM(6) = CCM(2)
      CM(7) = CCM(3)+CCM(4)
      CM(8) = CCM(7)
      CM(9) = CCM(8)
      EPSNA = 1.E-10
      IF (CM(7).GT.EPSNA) FNA=CCM(3)/CM(7)
      CALL BEQ(0,0,0,323.,X,CM,PP,SS,IPH,PH,FNA)
      SSOUT(IOUT) = SS(3)*100.
      DEL = 2.*(X(11)+X(17))+X(1)+X(12)+X(13)+X(18)+X(19)+X(24)+X(25)
     1 -2.*(X(5)+X(8)+X(10)+X(40))-X(2)-X(4)-X(7)-X(9)-X(23)-X(29)-X(30)
     2 -X(31)-X(39)
      ANF = 2.*(CM(5)+CM(6))+CM(7)
      IIB(IOUT) = 100.*DEL/ANF
      GO TO 100
  300 CONTINUE
      IF (IOUT.GT.200) IOUT=200
      DO 400 I=1,IOUT
      WRITE (6,500) CASE(I),SSOUT(I),IIB(I)
  400 CONTINUE
  500 FORMAT (1H ,5X,I3,2X,F4.0,2X,F6.1)
      WRITE (7,600)
  600 FORMAT (//1H ,'END OF DATA'/)
      STOP
      END
      SUBROUTINE KCALC (JJ,JS,X,SS,K)                                   KC200010
C***********************************************************************KC200020
C****** THIS ROUTINE DETERMINES ACTIVITY COEFFICIENTS, GAM, AND         KC200030
C       EQUILIBRIUM CONSTANTS, K, FOR THE SO2,CO2,SO3,N205,CA,MG,NA,CL  KC200040
C       SYSTEM.                                                         KC200050
C***********************************************************************KC200060
      COMMON/TEMP/AC,BC,CPK(2),CK(50)                                   KC200070
      COMMON/GAMMA/GAM(50)                                              KC200080
      COMMON/COMP/LON                                                   KC200090
      DIMENSION A(11),B(11),C(41),CC(11),U(11),SS(3)                    KC200100
      REAL K(50),X(50)                                                  KC200110
      DATA  A/6.,3.,3.,4.5,4.5,3.0,4.5,3.00,2.,5.,4./                   KC200120
      DATA  B/.4,.3,.3,0.,0.,0.0,.1,.30,-.2,.1,0./                      KC200130
      DATA  C/1.,1.,0.,1.,4.,0.,1.,4.,1.,4.,4.,1.,1.,0.,0.,0.,          KC200140
     1 4.,1.,1.,0.,0.,0.,1.,1.,1.,0.,0.,0.,1.,1.,1.,0.,0.,0.,0.,0.,0.,0.KC200150
     1 ,1.,4.,0./                                                       KC200160
      DATA  CC/1.,1.,0.,1.,4.,4.,4.,4.,1.,1.,1./                        KC200170
      DATA  U/0.,0.,.076,0.,0.,0.,0.,0.,0.,0.,0./                       KC200180
      GAM(12) = 1.                                                      KC200190
      IF(JS.NE.0.AND.JJ.EQ.1) GO TO 42                                  KC200200
      FI = 0.                                                           KC200210
      DO 20 I=1,41                                                      KC200220
      FI = FI+X(I)*C(I)                                                 KC200230
   20 CONTINUE                                                          KC200240
      FI = FI/2.                                                        KC200250
      SFI = SQRT(FI)                                                    KC200260
      IT2 = 11                                                          KC200270
      IF(LON.EQ.0) IT2 = 8                                              KC200280
      DO 40 I=1,IT2                                                     KC200290
      DNM = 1.+BC*A(I)*SFI                                              KC200300
      ACF = AC*CC(I)                                                    KC200310
      UM = 2.3026*U(I)                                                  KC200320
      GAM(I) = EXP(ACF*(-SFI/DNM+B(I)*FI)+UM*FI)                        KC200330
   40 CONTINUE                                                          KC200340
      GO TO 50                                                          KC200350
   42 CONTINUE                                                          KC200360
      GAM(1) = 0.8                                                      KC200370
      GAM(2) = 0.8                                                      KC200380
      GAM(3) = 1.                                                       KC200390
      GAM(4) = 0.8                                                      KC200400
      GAM(5) = 0.4                                                      KC200410
      GAM(6) = 0.4                                                      KC200420
      GAM(7) = 0.4                                                      KC200430
      GAM(8) = 0.4                                                      KC200440
      GAM(9) = 0.8                                                      KC200450
      GAM(10) = 0.6                                                     KC200460
      GAM(11) = 0.8                                                     KC200470
   50 CONTINUE                                                          KC200480
      K(1) = CK(1)/(GAM(1)*GAM(2))                                      KC200490
      K(2) = GAM(3)/CPK(2)                                              KC200500
      G314 = GAM(3)/(GAM(1)*GAM(4))                                     KC200510
      K(3) = CK(3)*G314                                                 KC200520
      G415 = GAM(4)/(GAM(1)*GAM(5))                                     KC200530
      K(4) = CK(4)*G415                                                 KC200540
      K(5) = CK(5)*G314                                                 KC200550
      K(6) = CK(6)*G415                                                 KC200560
      K(7) = CK(7)*GAM(2)/(GAM(1)*GAM(6))                               KC200570
      K(8) = CK(8)/GAM(7)                                               KC200580
      K(9) = CK(9)*GAM(2)/(GAM(7)*GAM(4))                               KC200590
      G375 = GAM(3)/(GAM(7)*GAM(5))                                     KC200600
      K(10) = CK(10)*G375                                               KC200610
      K(11) = CK(11)*G375                                               KC200620
      G76 = GAM(7)*GAM(6)                                               KC200630
      K(12) = CK(12)*GAM(3)/G76                                         KC200640
      K(13) = CK(13)/GAM(8)                                             KC200650
      K(14) = CK(14)*GAM(2)/(GAM(8)*GAM(4))                             KC200660
      G385 = GAM(3)/(GAM(8)*GAM(5))                                     KC200670
      K(15) = CK(15)*G385                                               KC200680
      K(16) = CK(16)*G385                                               KC200690
      K(17) = CK(17)*GAM(3)/(GAM(8)*GAM(6))                             KC200700
      K(23) = GAM(3)/CPK(1)                                             KC200710
      IF(LON.EQ.1) GO TO 60                                             KC200720
      DO 45 I=24,29                                                     KC200730
      K(I) = 1.                                                         KC200740
   45 CONTINUE                                                          KC200750
      DO 46 I=40,42                                                     KC200760
      K(I) = 1.                                                         KC200770
   46 CONTINUE                                                          KC200780
      GO TO 70                                                          KC200790
   60 CONTINUE                                                          KC200800
      K(24) = CK(18)*GAM(2)/(GAM(7)*GAM(9))                             KC200810
      K(25) = CK(19)*GAM(3)/(GAM(10)*GAM(9))                            KC200820
      K(26) = CK(20)*GAM(3)/(GAM(2)*GAM(10))                            KC200830
      K(27) = CK(21)*GAM(3)/(GAM(4)*GAM(10))                            KC200840
      K(28) = CK(22)*GAM(2)/(GAM(5)*GAM(10))                            KC200850
      K(29) = CK(23)*GAM(2)/(GAM(6)*GAM(10))                            KC200860
      K(40) = CK(30)*GAM(3)/(GAM(1)*GAM(2))                             KC200870
      K(41) = CK(31)*GAM(2)/(GAM(1)*GAM(6))                             KC200880
      K(42) = CK(32)*GAM(3)/G76                                         KC200890
   70 CONTINUE                                                          KC200900
      G75 = GAM(7)*GAM(5)                                               KC200910
      K(34) = CK(24)*SS(2)/G75                                          KC200920
      K(35) = CK(25)*SS(1)/G75                                          KC200930
      K(36) = CK(26)*SS(3)/G76                                          KC200940
      G22 = 1./(GAM(2)*GAM(2))                                          KC200950
      K(37) = CK(27)*G22/GAM(7)                                         KC200960
      K(38) = CK(28)/(GAM(8)*GAM(5))                                    KC200970
      K(39) = CK(29)*G22/GAM(8)                                         KC200980
      RETURN                                                            KC200990
      END                                                               KC201000
C                                                                       KC201010
C                                                                       KC201020
C                                                                       KC201030
C                                                                       KC201040
C                                                                       KC201050
C                                                                       KC201060
C                                                                       KC201070
C                                                                       KC201080
C                                                                       KC201090
C                                                                       KC201100
```

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C                                                                       KC201110
C                                                                       KC201120
C                                                                       KC201130
C                                                                       KC201140
C                                                                       KC201150
C                                                                       KC201160
C                                                                       KC201170
      SUBROUTINE TCON(JS,TK)                                            KC201180
C****** TEMPERATURE-DEPENDENT CONSTANTS ARE DETERMINED HERE.            KC201190
      COMMON/COMP/LON                                                   KC201200
      COMMON/TEMP/AC,BC,CPK(2),CK(50)                                   KC201210
      DIMENSION A(32),B(32),C(32),D(32)                                 KC201220
C                                                                       KC201230
      DATA  A/4470.99,0.,3404.71,2902.39,-843.67,-633.84,475.14,        KC201240
     1 -273.,-301.85,-475.48,-504.8,2572.1,-517.99,-235.08,-504.8,      KC201250
     2 -432.5,-1057.86,-1245.,0.,0.,0.,-303.41,-241.,-1660.,0.,4944.0,  KC201260
     3 530.49,-955.14,-480.85,0.,0.,0./                                 KC201270
C                                                                       KC201280
      DATA  B/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,23.15,0.,0.,0.,0.,0.,    KC201290
     1 0.,0.,0.,0.,0.,0.,0.,0.,37.745,-12.9722,0.,0.,0.,0.,0./          KC201300
C                                                                       KC201310
      DATA  C/.01706,0.,.032786,.02379,0.,0.,.018222,0.,0.,0.,0.,       KC201320
     1 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,.032331,0.,0.       KC201330
     2 ,0.,0.,0./                                                       KC201340
C                                                                       KC201350
      DATA  D/6.0875,0.,14.8435,6.4980,-4.7171,-9.3320,5.0435,-2.29,    KC201360
     1 -2.272,-4.7954,-5.091,63.60,-4.3223,-1.747,-5.091,-4.3715,-5.7950KC201370
     2 ,-4.49,.40,.57,.25,-2.2852,-1.529,-13.88,-6.347,105.36,-25.7085, KC201380
     3 -7.871,-12.514,-4.420,-5.495,-2.602/                             KC201390
C                                                                       KC201400
      EPS = .000001                                                     KC201410
      IF(JS.EQ.JSOLD.AND.LON.EQ.LONOLD.AND.ABS(TK-TOLD).LT.EPS) RETURN  KC201420
      TC = TK-273.16                                                    KC201430
      TC2 = TC*TC                                                       KC201440
      DC = 87.740-0.40008*TC+9.398E-4*TC2-1.410E-6*TC2*TC               KC201450
      DCTK = DC*TK                                                      KC201460
      SQDCTK = SQRT(DCTK)                                               KC201470
      AC = 1.8246E6*2.3026/(DCTK*SQDCTK)                                KC201480
      BC = 50.29/SQDCTK                                                 KC201490
      DM = 2.3025851                                                    KC201500
      TLOG = ALOG10(TK)                                                 KC201510
      DO 10 I=1,32                                                      KC201520
      CK(I) = EXP(DM*(-A(I)/TK-B(I)*TLOG-C(I)*TK+D(I)))                 KC201530
   10 CONTINUE                                                          KC201540
CC*   IF(JS.NE.1.AND.TC.GT.40.) CK(26) = EXP(DM*(-1200.9/TK+6.6489*TLOG-KC201550
CC*  1 0.032057*TK-7.094))                                              KC201560
      CPK(1) = EXP(DM*(1370./TK-4.51))                                  KC201570
      CPK(2) = EXP(DM*(1015./TK-4.87))                                  KC201580
      TOLD = TK                                                         KC201590
      JSOLD = JS                                                        KC201600
      LONOLD = LON                                                      KC201610
      RETURN                                                            KC201620
      END                                                               KC201630
```

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BEQSOX   FORTRAN  P ID=BECAQX    09.13.02  MONDAY 8 JUNE 1981        PAGE 1
   NATIONAL CSS, INC. (SUNNYVALE DATA CENTER)           SUNY

      SUBROUTINE CASO3(IFLAG,K,X,CM,PP,SOL6)                          CS200010
      DIMENSION X(50),CM(10),PP(2),IFLAG(10)                          CS200020
      COMMON/CEE/C1,C3,C5,C6,C7,F1,F3                                 CS200030
      REAL K(50)                                                      CS200040
      IT = 5                                                          CS200050
      IF(IFLAG(3).EQ.0.AND.IFLAG(4).EQ.0.AND.IFLAG(6).EQ.0            CS200060
     1 .AND.IFLAG(7).EQ.0) IT = 1                                     CS200070
      CM15 = ABS(CM(1)-CM(5))                                         CS200080
      CM15SQ = CM15*CM15                                              CS200090
      IF(CM(5).GT.CM(1)) GO TO 200                                    CS200100
      X(11) = 0.                                                      CS200110
      X(17) = 0.                                                      CS200120
      X(25) = 0.                                                      CS200130
      DO 100 I=1,IT                                                   CS200140
      IF(IFLAG(3).EQ.1) X(10) = CM(3)/(C3+X(11)/K(12)+X(17)/K(17)     CS200150
     1 +X(25)/K(29))                                                  CS200160
      IF(IFLAG(4).EQ.1) X(23) = CM(4)/(1.+X(11)/K(24)+X(25)/K(25))    CS200170
      F1 = C1+X(17)/K(16)                                             CS200180
      F5 = C5+X(10)/K(12)+X(23)/K(24)                                 CS200190
      DISC = CM15SQ+4.*K(35)*F5*F1                                    CS200200
      X(8) = (CM15+SQRT(DISC))/(2.*F1)                                CS200210
      X(11) = K(35)/X(8)                                              CS200220
      IF(IFLAG(6).EQ.0) GO TO 50                                      CS200230
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))                       CS200240
      X(17) = AMIN1(X(17),SOL6)                                       CS200250
   50 CONTINUE                                                        CS200260
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))    CS200270
  100 CONTINUE                                                        CS200280
      F1 = C1+X(11)/K(11)+X(17)/K(16)                                 CS200290
      RETURN                                                          CS200300
  200 CONTINUE                                                        CS200310
      X(8) = 0.                                                       CS200320
      X(10) = 0.                                                      CS200330
      X(23) = 0.                                                      CS200340
      DO 250 I=1,IT                                                   CS200350
      IF(IFLAG(6).EQ.0) GO TO 230                                     CS200360
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))                       CS200370
      X(17) = AMIN1(X(17),SOL6)                                       CS200380
  230 CONTINUE                                                        CS200390
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))    CS200400
      F1 = C1+X(17)/K(16)                                             CS200410
      F5 = C5+X(10)/K(12)+X(23)/K(24)                                 CS200420
      DISC = CM15SQ+4.*K(35)*F5*F1                                    CS200430
      X(11) = (CM15+SQRT(DISC))/(2.*F5)                               CS200440
      X(8) = K(35)/X(11)                                              CS200450
      IF(IFLAG(3).EQ.1) X(10) = CM(3)/(C3+X(11)/K(12)+X(17)/K(17)     CS200460
     1 +X(25)/K(25))                                                  CS200470
  250 CONTINUE                                                        CS200480
      F1 = C1+X(11)/K(11)+X(17)/K(16)                                 CS200490
      RETURN                                                          CS200500
      END                                                             CS200510
C                                                                     CS200520
C                                                                     CS200530
C                                                                     CS200540
C                                                                     CS200550
```

```
      SUBROUTINE CASO4 (IFLAG,K,X,CM,PP,SOL6)                           CS200560
      DIMENSION X(50),CM(10),PP(2),IFLAG(10)                            CS200570
      COMMON/CEE/C1,C3,C5,C6,C7,F1,F3                                   CS200580
      REAL K(50)                                                        CS200590
      IT = 5                                                            CS200600
      IF(IFLAG(1).EQ.0.AND.IFLAG(4).EQ.0.AND.IFLAG(6).EQ.0.AND.IFLAG(7) CS200610
     1.EQ.0) IT = 1                                                     CS200620
      CM35 = ABS(CM(3)-CM(5))                                           CS200630
      CM35SQ = CM35*CM35                                                CS200640
      IF(CM(5).GT.CM(3)) GO TO 200                                      CS200650
      X(11) = 0.                                                        CS200660
      X(17) = 0.                                                        CS200670
      X(25) = 0.                                                        CS200680
      DO 100 I=1,IT                                                     CS200690
      IF(IFLAG(1).EQ.1) X(8) = CM(1)/(C1+X(11)/K(11)+X(17)/K(16))       CS200700
      IF(IFLAG(4).EQ.1) X(23) = CM(4)/(1.+X(11)/K(24)+X(25)/K(25))      CS200710
      F3 = C3+X(17)/K(17)+X(25)/K(29)                                   CS200720
      F5 = C5+X(8)/K(11)+X(23)/K(24)                                    CS200730
      DISC = CM35SQ+4.*K(36)*F5*F3                                      CS200740
      X(10) = (CM35+SQRT(DISC))/(2.*F3)                                 CS200750
      X(11) = K(36)/X(10)                                               CS200760
      IF(IFLAG(6).EQ.0) GO TO 50                                        CS200770
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))                         CS200780
      X(17) = AMIN1(X(17),SOL6)                                         CS200790
   50 CONTINUE                                                          CS200800
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))      CS200810
  100 CONTINUE                                                          CS200820
      F3 = C3+X(11)/K(12)+X(17)/K(17)+X(25)/K(29)                       CS200830
      RETURN                                                            CS200840
  200 CONTINUE                                                          CS200850
      X(8) = 0.                                                         CS200860
      X(10) = 0.                                                        CS200870
      X(23) = 0.                                                        CS200880
      DO 250 I=1,IT                                                     CS200890
      IF(IFLAG(6).EQ.0) GO TO 230                                       CS200900
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))                         CS200910
      X(17) = AMIN1(X(17),SOL6)                                         CS200920
  230 CONTINUE                                                          CS200930
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))      CS200940
      F3 = C3+X(17)/K(17)+X(25)/K(29)                                   CS200950
      F5 = C5+X(8)/K(11)+X(23)/K(24)                                    CS200960
      DISC = CM35SQ+4.*K(36)*F5*F3                                      CS200970
      X(11) = (CM35+SQRT(DISC))/(2.*F5)                                 CS200980
      X(10) = K(36)/X(11)                                               CS200990
      IF(IFLAG(1).EQ.1) X(8) = CM(1)/(C1+X(11)/K(11)+X(17)/K(16))       CS201000
  250 CONTINUE                                                          CS201010
      F3 = C3+X(11)/K(12)+X(17)/K(17)+X(25)/K(29)                       CS201020
      RETURN                                                            CS201030
      END                                                               CS201040
C                                                                       CS201050
C                                                                       CS201060
C                                                                       CS201070
C                                                                       CS201080
C                                                                       CS201090
C                                                                       CS201100
```

```
      SUBROUTINE CASOX (IFLAG,K,X,CM,PP,SOL6)
      DIMENSION X(50),CM(10),PP(2),IFLAG(10)
      COMMON/CEE/C1,C3,C5,C6,C7,F1,F3
      REAL K(50)
      IT = 5
      IF(IFLAG(4).EQ.0.AND.IFLAG(6).EQ.0.AND.IFLAG(7).EQ.0) IT = 1
      CM135 = ABS(CM(1)+CM(3)-CM(5))
      C135SQ = CM135*CM135
      IF(CM(5).GT.(CM(1)+CM(3))) GO TO 200
      X(11) = 0.
      X(17) = 0.
      X(25) = 0.
      DO 100 I=1,IT
      IF(IFLAG(4).EQ.1) X(23) = CM(4)/(1.+X(11)/K(24)+X(25)/K(25))
      F1 = C1+X(17)/K(16)
      F3 = C3+X(17)/K(17)+X(25)/K(29)
      F5 = C5+X(23)/K(24)
      THF = F1+F3*K(36)/K(35)
      DISC = C135SQ+4.*K(35)*F5*THF
      X(8) = (CM135+SQRT(DISC))/(2.*THF)
      X(11) = K(35)/X(8)
      X(10) = K(36)/X(11)
      IF(IFLAG(6).EQ.0) GO TO 50
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))
      X(17) = AMIN1(X(17),SOL6)
   50 CONTINUE
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))
  100 CONTINUE
      F1 = C1+X(11)/K(11)+X(17)/K(16)
      F3 = C3+X(11)/K(12)+X(17)/K(17)+X(25)/K(29)
      RETURN
  200 CONTINUE
      X(8) = 0.
      X(10) = 0.
      X(23) = 0.
      DO 250 I=1,IT
      IF(IFLAG(6).EQ.0) GO TO 230
      X(17) = CM(6)/(C6+X(8)/K(16)+X(10)/K(17))
      X(17) = AMIN1(X(17),SOL6)
  230 CONTINUE
      IF(IFLAG(7).EQ.1) X(25) = CM(7)/(C7+X(10)/K(29)+X(23)/K(25))
      F1 = C1+X(17)/K(16)
      F3 = C3+X(17)/K(17)+X(25)/K(29)
      F5 = C5+X(23)/K(24)
      DISC = C135SQ+4.*F5*(F1*K(35)+F3*K(36))
      X(11) = (CM135+SQRT(DISC))/(2.*F5)
      X(8) = K(35)/X(11)
      X(10) = K(36)/X(11)
  250 CONTINUE
      F1 = C1+X(11)/K(11)+X(17)/K(16)
      F3 = C3+X(11)/K(12)+X(17)/K(17)+X(25)/K(29)
      RETURN
      END
```

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BQ2      FORTRAN  P ID=BECAQX    09.13.24  MONDAY 8 JUNE 1981          PAGE 1
   NATIONAL CSS, INC. (SUNNYVALE DATA CENTER)          SUNY

C***********************************************************************
C****** THIS ROUTINE CALLS BEQ TO DETERMINE AQUEOUS
C       SOLUTION EQUILIBRIA FOR THE SYSTEM CA,MG,NA,K,SO3,SO4,CO3,CL.
C       (NITRATES ASSUMED ZERO FOR INPUT/OUTPUT CONVENIENCE)
C
C****** FOR JS=1 AND SPECIFIED PPCO2, SOLIDS ARE ALSO DETERMINED.
C
C           PROGRAM USES 'BEQ EXEC'.V
C**********************************************************************
      DIMENSION X(50),CM(10),PP(2),SS(3),XMW(10)
      COMMON /ID/IDENT(20), CCM(10), CW(10)
      COMMON /INPUT/ PPSO2, PPCO2, SS1,SS2, SS3, KK1, JJS, PPH
      REAL*8 CMP(10) /'CA++', 'MG++', 'NA+', 'K+', 'SO3--',
     1 'SO4', 'CO3', 'CL-', 'H2AD', ' '/
      REAL*8 DATE, HMS
      DATA XMW /40.08,24.31,22.99,39.10,80.06,96.06,60.01,35.45,
     1  146.,0.0/
C
C            NOPR  = 0: NO PRINTOUT FROM SUBROUTINE BPR
C                    1: FULL PRINTOUT
C                    2: SHORT FORM PRINTOUT
C
C            K1    = 1: INPUT CONCS IN PPM
C                    2: INPUT CONCS IN G-MOLE/LITER
C
C            JS    = 0: NO SOLIDS
C                  = 1: SOLIDS MAY BE PRESENT. PPCO2 SPECIFIED.
C
C            TK    =    SLURRY TEMPERATURE, DEGREES KELVIN
C
C            PP    =    PARTIAL PRESSURES OF SO2,CO2 IN ATM
C
C            SS(1) =    RELATIVE SATURATION OF CASO3 AT WHICH
C                       CRYSTALLIZATION OCCURS. USE VALUE OF 1.00
C                       FOR NORMAL RADIAN EQUILIBRIUM.
C
C            SS(3)      APPLIES TO CASO4
C
C            IPH   = 0: PH NOT SPECIFIED
C                    1: PH IS SPECIFIED
C
C            PH    =    SLURRY PH (FOR INPUT, SET = 0. IF NOT SPECIFIED)
C
C            CCM   =    INPUT DATA CONCS OF CA,MG,NA,K,SO3,SO4,CO3,CL
C                       IN THAT ORDER.
C
C            CM    =    CONCS OF SO3,CO3,SO4,NO3,CA,MG,(NA+K),CL
C                       IN THAT ORDER, GMOL/LITER
C
100   CONTINUE
C          READ A NEW CASE:  INPUT DATA FROM FILE 'BEQ DATA'.
      READ (5,110,END=200) IDENT
110   FORMAT( 20A4)
      CALL TIMES (ICPU, ITOD, HMS, DATE)
      WRITE (6,112) DATE, HMS
```

```
112   FORMAT( 1H1, 50X, A8, ' AT ', A5)
      WRITE (6,115) IDENT
115   FORMAT(1H , 5X, 20A4)
      READ (5,120,END=160) XPR, XK1, SJ, TK, PP(1), PP(2), SS(1),
     1 SS(2),SS(3), XIPH, PH
      READ (5,120,END=160) (CCM(I),I=1,9)
120   FORMAT( 11G99.0)
      K1 = XK1
      NOPR = XPR
C           CHECK INPUT CONCNS:
      DO 3 I = 1,9
      IF (CCM(I).GE.0.) GO TO 3
      WRITE (6,170) CMP(I), CCM(I)
170   FORMAT( 1H0, 'INPUT ERROR; CONCN OF ',A8, ' IS NEGATIVE: ',F12.5/
     1 6X, 'SKIP TO NEXT CASE.')
      GO TO 100
3     CONTINUE
C           CALC CONCNS IN GMOL/L AND PPM:
      IF(K1.EQ.1) GO TO 20
      DO 10 I = 1,9
      CW(I) = 1000. * CCM(I) * XMW(I)
   10 CONTINUE
      GO TO 40
   20 CONTINUE
      DO 30 I = 1,9
      CW(I) = CCM(I)
      CCM(I) = 0.001 * CCM(I) / XMW(I)
30    CONTINUE
   40 CONTINUE
C           DO MODIFIED RADIAN CALC:
      EPS = .00000001
      JS = SJ
      IPH = XIPH
      PPSO2 = PP(1)
      PPCO2 = PP(2)
      SS1 = SS(1)
      SS2 = SS(2)
      SS3 =SS(3)
      KK1 = K1
      JJS = JS
      PPH = PH
      IF(TK.GT.253.) GO TO 45
      WRITE (6,175) TK
175   FORMAT( 1H0, 'INPUT TEMP OF ', F6.1, ' K IS TOO LOW FOR',
     1 ' RADIAN CALC;' / 6X, 'SKIP TO NEXT CALC.')
      GO TO 100
   45 CONTINUE
      CM(1) = CCM(5)
      CM(2) = CCM(7)
      CM(3) = CCM(6)
      CM(4) = 0.
      CM(5) = CCM(1)
      CM(6) = CCM(2)
      CM(7) = CCM(3)+CCM(4)
      CM(8) = CCM(8)
      CM(9) = CCM(9)                                                    LCA01110
      EPSNA = 1.E-10                                                    LCA01120
      IF(CM(7).GT.EPSNA) FNA = CCM(3)/CM(7)                             LCA01130
      IOPT = 0                                                          LCA01140
      IF(PP(2).GT.EPS) IOPT = 2                                         LCA01150
      IF(PP(1).GT.EPS) IOPT = IOPT+1                                    LCA01160
      CALL BEQ (NOPR,JS,IOPT,TK,X,CM,PP,SS,IPH,PH,FNA)                  LCA01170
      GO TO 100                                                         LCA01180
  160 CONTINUE                                                          LCA01190
      WRITE (6,180)                                                     LCA01200
180   FORMAT( 1H0, 'INPUT DATA INCOMPLETE FOR THIS CASE.')              LCA01210
200   CONTINUE                                                          LCA01220
      WRITE(6,210)                                                      LCA01230
210   FORMAT(1H0,'END OF DATA')                                         LCA01240
 1000 CONTINUE                                                          LCA01250
      STOP                                                              LCA01260
      END                                                               LCA01270
```

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BEQ       EXEC     P ID=BECAQX     09.14.49  MONDAY 8 JUNE 1981            PAGE 1
   NATIONAL CSS, INC. (SUNNYVALE DATA CENTER)         SUNY

&TYPE ERROR                                                              LIQ00010
FILEDEF 5 DSK BEQ DATA                                                   LIQ00020
LOAD  BQ2 BQ2CON BEQSOX BQ2IT BQ2PR (CLEAR)                              LIQ00030
START                                                                    LIQ00040
```

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LIQ       EXEC     P ID=BECAQX    09.15.02  MONDAY 8 JUNE 1981           PAGE 1
   NATIONAL CSS, INC. (SUNNYVALE DATA CENTER)          SUNY


&TYPE ERROR                                                              LIQ00010
FILEDEF 5 DSK LIQ DATA                                                   LIQ00020
FILEDEF 7 CON                                                            LIQ00030
LOAD LIQ BQ2IT BEQSOX BQ2PR BQ2CON (CLEAR)                               LIQ00040
START                                                                    LIQ00050
```

APPENDIX L

CYLINDER SETTLING AND FUNNEL FILTRATION TEST DATA

Table L-1

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxidation Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
951-1A	4	0.18	0.14-0.23	66	62-71	71	71-72	86	82-89	16	14-17	L	High	5.6	95.0	2-loop	2	-
901-1A	5	0.99	0.84-1.16	70	65-76	72	71-74	85	82-88	15	15-16	LS	High	4.5	98.0	2-loop	2	-
952-1A	6	0.38	0.11-0.75	62	55-70	69	64-72	85	81-88	16	12-19	L	High	5.5	97.0	2-loop	2	1500
902-1A	6	0.39	0.30-0.70	79	76-83	68	60-71	86	80-92	15	13-18	LS	High	4.5	98.0	2-loop	2	2045
902-1B	2	0.34	0.33-0.34	74	70-77	73	72-73	88	85-91	15	13-17	LS	High	4.0	99.0	2-loop	2	2355
903-1A	4	0.50	0.40-0.50	66	60-74	68	61-71	83	77-89	15	14-16	LS	High	4.7	98.0	2-loop	2	3510
904-1A	2	0.50	0.40-0.50	59	59	64	61-67	80	75-85	12	11-14	LS	High	4.8	98.0	2-loop	2	3690
905-1A	9	0.40	0.30-0.50	70	59-81	73	67-76	85	82-88	15	14-16	LS	High	4.6	99.0	2-loop	2	2315
906-1A	3	0.40	0.30-0.50	65	64-65	67	62-70	84	78-90	15	14-16	LS	High	4.5	98.5	2-loop	2	2495
907-1A	11	0.60	0.40-0.80	69	62-76	72	69-77	87	82-92	15	14-16	LS	High	4.7	98.5	2-loop	2	2360
907-1B	33	0.50	0.30-0.90	68	59-76	71	59-76	85	78-92	15	12-18	LS	High	4.7	98.0	2-loop	2	2160
827-1A	3	1.15	0.96-1.51	63	56-70	71	67-74	85	81-88	12	10-12	LS	High	5.4	71.1	2-loop	2	-
828-1A	1	0.77	0.77	54	54	75	75	84	83-85	12	12	LS	High	5.6	65.3	2-loop	2	-
829-1A	5	1.00	0.51-1.30	64	52-79	69	68-70	79	73-84	12	12	LS	High	5.8	64.9	2-loop	2	-
909-1A	5	1.10	0.83-1.86	84	65-88	67	60-69	83	65-91	16	14-18	LS	High	5.6	95.0	Bleed stream	-	1373
910-1A	5	0.40	0.10-0.75	63	52-78	60	56-66	76	64-87	18	17-20	LS	High	7.0	71.0	Bleed stream	-	1516
911-1A	4	1.00	0.76-1.53	70	62-81	66	64-70	84	80-88	20	19-20	LS	High	5.7	96.0	Bleed stream	-	1816
912-1A	2	0.55	0.18-0.91	61	52-69	64	62-65	71	57-85	18	15-24	LS	High	6.8	40.0	Bleed stream	-	1802
913-1A	1	0.70	0.70	73	73	47	47	79	79	19	19	LS	High	5.5	95.0	Bleed stream	-	1430
VAA-101	2	0.54	0.38-0.70	35	32-38	55	51-59	53	51-54	7.4	6.4-8.3	L	High	6.6	25.5	-	-	1616
VAA-104	1	0.45	0.45	38	38	52	52	61	61	8.3	8.3	L	High	6.1	23.2	-	-	1602
VAA-106	1	0.99	0.99	58	58	54	54	41	41	9.1	9.1	L	High	5.9	18.3	-	-	2059
VAA-002	2	0.10	0.09-0.10	43	41-45	71	70-71	-	-	13	11-14	LS	High	5.8	16.0	-	-	472
VAA-306	1	0.21	0.21	66	66	61	61	67	63-69	20	20	LS	High	4.8	61.9	-	-	944
VAA-308	1	0.22	0.22	60	60	59	59	62	60-64	14	14	LS	High	5.3	37.5	-	-	858
VAA-311	1	0.10	0.10	39	39	60	60	70	69-71	14	14	LS	High	5.7	70.2	2-loop	2	744
VAA-312	1	1.93	1.93	61	61	67	67	80	79-80	12	12	LS	High	5.2	98.2	2-loop	2	915
VAA-315	1	1.13	1.13	71	71	63	63	81	80-83	15	15	LS	High	5.4	98.6	2-loop	2	1001
VAA-017	1	0.10	0.10	32	32	52	52	-	-	14	14	LS	High	5.2	13.8	-	-	1258
VAA-018	2	0.20	0.17-0.23	48	46-50	57	55-60	-	-	15	14-16	LS	High	5.1	37.2	-	-	1245
VAA-020	2	0.28	0.12-0.44	52	50-53	56	51-60	-	-	15	14-15	LS	High	5.2	8.7	-	-	1545
VAA-027	1	0.96	0.96	62	62	66	66	78	76-81	15	15	LS	High	5.1	95.3	2-loop	2	1375
VAA-029	1	0.65	0.65	62	62	59	59	80	79-81	15	15	LS	High	4.7	98.7	2-loop	2	1916

Table L-1 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxidation Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
VAA-031	1	0.54	0.54	73	73	65	65	82	81-82	14	14	LS	High	5.0	99.8	2 Loop	2	1745
VAA-025	1	0.09	0.09	46	46	66	66	64	60-66	19	19	LS	High	4.8	75.5	-	-	2145
VAA-021	1	0.08	0.08	53	53	53	53	65	64-67	25	25	LS	High	4.7	30.0	-	-	1773
VAA-022	1	0.13	0.13	54	54	57	57	66	64-69	20	20	LS	High	5.0	23.4	-	-	1659
VAA-038	1	1.60	1.60	95	95	62	62	72	68-74	21	21	LS	High	4.5	52.5	-	-	2116
VAA-041	1	0.47	0.47	83	83	63	63	66	64-68	20	20	LS	High	4.8	27.1	-	-	2116
VAA-042	1	0.24	0.24	68	68	57	57	69	68-71	22	22	LS	High	4.8	29.2	-	-	2374
VAA-036	1	1.00	1.00	61	61	58	58	67	67-68	21	21	LS	High	4.8	25.8	-	-	2488
VAA-110	1	0.70	0.70	52	52	72	72	55	53-57	8.0	8.0	L	High	7.2	22.7	-	-	2917
VAA-112	3	0.64	0.53-0.84	53	41-68	51	50-53	56	51-60	8.5	8.1-8.9	L	High	5.9	21.5	-	-	1659
VAA-114	3	1.54	0.79-2.54	52	49-55	55	51-60	-	-	8.3	8.1-8.6	L	High	6.7	20.3	-	-	296
VAA-201	2	0.07	0.06-0.08	22	21-22	51	48-54	54	53-58	9.4	8.6-10	LS	High	5.8	10.7	-	-	687
VAA-206	2	0.07	0.06-0.07	43	43	53	53	57	56-60	15	15-16	LS	High	5.7	13.4	-	-	544
VAA-203	1	0.06	0.06	42	42	53	53	55	54-56	15	15	LS	High	5.8	17.2	-	-	801
VAA-204	1	0.08	0.08	49	49	50	50	48	42-53	15	15	LS	High	5.7	14.1	-	-	686
VAA-208	1	0.07	0.07	44	44	52	52	54	54-55	15	15	LS	High	5.6	14.8	-	-	572
VAA-209	1	0.07	0.07	40	40	47	47	53	53-54	17	17	LS	High	5.7	15.9	-	-	601
VAA-212	1	0.12	0.12	49	49	46	46	55	54-56	14	14	LS	High	5.6	21.0	-	-	572
VAA-220	2	0.42	0.27-0.56	61	56-66	55	47-63	74	73-75	15	15	LS	High	4.6	80.8	-	-	944
VAA-217	1	0.04	0.04	29	29	69	69	71	66-76	15	15	LS	High	5.7	56.9	-	-	915
VAA-221	1	0.04	0.04	29	29	56	56	60	57-61	16	16	LS	High	5.5	43.5	-	-	1201
VAA-224	1	0.08	0.08	52	52	49	49	64	64	16	16	LS	High	5.6	32.0	-	-	1316
VAA-222	1	0.25	0.25	57	57	54	54	59	59-60	14	14	LS	High	5.5	34.1	-	-	1115
VAA-225	1	0.09	0.09	50	50	57	57	63	62-64	15	15	LS	High	5.4	30.3	-	-	1058
VAA-227	1	0.10	0.10	54	54	59	59	62	62	15	15	LS	High	5.5	32.2	-	-	1087
VAA-228	1	0.12	0.12	48	48	57	57	62	59-66	16	16	LS	High	4.9	53.7	-	-	1287
VAA-229	1	0.40	0.40	67	67	61	61	74	72-76	15	15	LS	High	4.7	71.5	-	-	1344
VAA-230	1	0.03	0.03	33	33	53	53	62	60-66	16	16	LS	High	5.7	51.2	-	-	1030
VAA-231	2	0.06	0.06-0.07	45	38-52	55	54-56	59	57-61	16	15-16	LS	High	5.1	45.5	-	-	1273
VAA-233	1	0.28	0.28	57	57	61	61	59	57-61	15	15	LS	High	4.7	69.1	-	-	1487
VAA-235	1	0.05	0.05	34	34	51	51	61	61-62	15	15	LS	High	5.4	37.7	-	-	1373
VAA-232	1	0.07	0.07	48	48	55	55	66	64-68	17	17	LS	High	5.0	39.3	-	-	1430
VAA-236	1	0.24	0.24	63	63	53	53	58	58-59	15	15	LS	High	5.3	-	-	-	1487
VAA-238	2	0.16	0.08-0.25	49	46-52	56	55-58	62	61-62	16	16	LS	High	5.4	27.5	-	-	1859
VAA-239	1	0.10	0.10	49	49	56	56	60	60-61	15	15	LS	High	5.7	15.3	-	-	1630
VAA-243	1	0.12	0.12	48	48	52	52	59	58-60	14	14	LS	High	5.6	22.0	-	-	1888

Table L-1 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxidation Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
VAA-248	1	0.21	0.21	51	51	53	53	58	58-59	15	15	LS	High	5.5	21.6	-	-	1859
VAA-249	1	0.14	0.14	56	56	57	57	66	64-68	19	19	LS	High	5.0	37.9	-	-	2402
VAA-240	1	0.13	0.13	49	49	59	59	67	65-70	15	15	LS	High	5.3	31.7	-	-	1916
VAA-247	1	0.08	0.08	48	48	59	59	66	64-68	15	15	LS	High	4.7	40.6	-	-	2231
VAA-250	1	0.10	0.10	49	49	63	63	68	67-69	16	16	LS	High	4.6	52.2	-	-	2345
VAA-241	1	0.08	0.08	56	56	56	56	64	63-65	17	17	LS	High	5.4	40.2	-	-	1630
VAA-224	1	0.16	0.16	51	51	56	56	63	62-64	16	16	LS	High	5.5	22.7	-	-	2517
926-1A	4	0.15	0.12-0.19	51	47-53	51	47-53	69	61-71	15	14-16	LS	High	4.6	50.6	-	-	4090
926-1G	4	0.12	0.11-0.13	46	44-47	61	59-63	70	65-75	14	13-16	LS	High	4.9	49.2	-	-	2066
926-1B	4	0.16	0.10-0.22	48	45-49	60	59-62	69	67-73	14	12-16	LS	High	5.0	48.0	-	-	1373
926-1C	4	0.13	0.08-0.18	49	43-53	59	56-61	66	64-72	15	15-16	LS	High	5.0	44.6	-	-	1459
926-1H	7	0.10	0.08-0.14	45	37-53	56	48-61	61	56-70	15	14-16	LS	High	5.2	29.3	-	-	1204
926-1D	4	0.14	0.05-0.36	52	38-64	54	47-61	60	54-68	16	15-17	LS	High	5.5	21.0	-	-	1230
926-1E	5	0.10	0.08-0.11	45	44-47	55	54-56	60	55-65	15	15	LS	High	5.0	31.9	-	-	795
927-1A	1	0.24	0.24	46	46	56	56	66	63-73	14	14	LS	High	5.1	33.7	-	-	772
927-1J	1	0.12	0.12	58	58	59	59	68	68	15	15	LS	High	5.4	25.5	-	-	715
927-1B	1	0.09	0.09	53	53	59	59	67	67	15	15	LS	High	5.2	37.5	-	-	744
927-1C	2	0.18	0.10-0.26	55	52-57	56	56	66	65-68	15	15	LS	High	5.1	26.0	-	-	1402
927-1D	1	0.07	0.07	49	49	57	57	68	67-70	14	14	LS	High	5.1	29.5	-	-	1316
927-1E	3	0.07	0.07-0.08	48	47-50	53	52-53	61	59-63	16	15-16	LS	High	5.1	33.5	-	-	3961
927-1G	1	0.12	0.12	60	60	53	53	63	63	14	14	LS	High	5.1	22.4	-	-	4033
927-1I	1	0.11	0.11	48	48	52	52	63	62-63	16	16	LS	High	5.2	38.1	-	-	4004
927-1F	1	0.18	0.18	52	52	54	54	63	63	15	15	LS	High	5.1	18.1	-	-	3747
927-1K	1	0.13	0.13	44	44	58	58	65	63-67	14	14	LS	High	4.8	17.6	-	-	3947
927-1L	1	0.23	0.23	54	54	57	57	68	66-69	14	14	LS	High	4.8	35.7	-	-	4118
914-1A	2	0.57	0.54-0.60	71	69-73	73	73	79	78-80	16	15-16	LS	High	4.7	99.0	1-loop	1	3961
927-1M	4	0.64	0.46-0.98	61	57-68	72	70-74	78	76-80	14	12-16	LS	High	4.9	99.6	1-loop	1	4211
927-1O	2	0.45	0.36-0.54	76	71-82	73	72-73	78	77-79	16	15-16	LS	High	4.5	99.7	1-loop	1	4176
927-1P	3	0.09	0.06-0.11	44	43-45	62	56-71	63	59-66	15	15	LS	High	5.1	21.0	-	-	3680
914-1C	3	0.10	0.09-0.12	44	39-49	59	56-60	65	62-68	14	14-15	LS	High	4.8	27.8	-	-	3823
915-1A	1	0.11	0.11	47	47	58	58	70	67-72	14	14	LS	High	5.2	67.9	Bleed Stream	-	3718
915-1B	1	0.09	0.09	50	50	57	57	79	79-80	16	16	LS	High	5.4	76.5	Bleed Stream	-	4147
915-1C	3	0.14	0.10-0.17	53	49-57	71	62-76	79	78-80	15	14-16	LS	High	4.8	95.1	Bleed Stream	-	4042
916-1A	2	0.49	0.46-0.52	70	68-72	73	70-76	79	78-79	16	15-16	LS	High	4.8	99.5	1-loop	2	3733
916-1B	3	0.50	0.47-0.53	63	57-73	67	64-67	76	74-78	15	14-16	LS	High	4.8	99.8	1-loop	2	3823

Table L-1 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE VENTURI/SPRAY TOWER SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxidation Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
916-1C	4	0.88	0.50-1.69	70	65-76	69	67-71	34(1)	26-42	15	15-16	LS	High	4.9	96.6	1-loop	2	2195
916-1D	6	1.09	0.68-1.47	72	66-78	73	72-74	84	80-88	15	14-16	LS	High	5.2	99.7	1-loop	2	1520
916-1E	4	0.89	0.68-1.29	71	65-77	70	68-72	88	87-90	15	14-16	LS	High	5.2	99.3	1-loop	2	1495
916-1F	2	0.57	0.55-0.59	71	71	75	73-77	84	83-85	16	15-16	LS	High	5.2	99.2	1-loop	2	1516
916-1G	2	1.20	0.92-1.47	67	67-68	73	71-74	85	82-88	15	14-15	LS	High	5.3	99.8	1-loop	2	1445
916-1H	2	0.06	0.05-0.07	41	36-46	54	54	59	58-60	15	15	LS	High	5.0	50.4	-	-	1416

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(1) System operated with clarifier only.

Table L-2

SETTLING AND FUNNEL TEST RESULTS FOR THE SPRAY TOWER SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxid. Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
SXX101	1	0.18	0.18	48	48	52	52	-	-	15	15	LS	High	5.2	32.6	-	-	-
SXX103	1	0.68	0.68	64	64	58	58	68	64-70	15	15	LS	High	5.0	34.8	-	-	-
SXX105	1	0.19	0.19	53	53	60	60	67	67	15	15	LS	High	5.4	17.9	-	-	-
SXX106	1	0.19	0.19	57	57	58	58	67	67	15	15	LS	High	5.5	21.7	-	-	-
SXX116	2	0.22	0.17-0.26	51	50-51	58	58	67	67-68	15	15	LS	High	5.8	19.0	-	-	-
SXX113	1	0.16	0.16	48	48	53	53	64	63-66	14	14	LS	High	5.8	13.2	-	-	-
SXX114	1	0.17	0.17	43	43	53	53	61	60-61	13	13	LS	High	5.8	19.6	-	-	-
SXX115	1	0.14	0.14	44	44	54	54	62	61-62	17	17	LS	High	5.8	12.7	-	-	-
SXX117	1	0.78	0.78	73	73	56	56	67	66-67	16	16	LS	High	5.8	10.8	-	-	-
SXX111	1	0.31	0.31	47	47	53	53	64	64	14	14	LS	High	5.5	7.8	-	-	-
SXX107	1	0.35	0.35	50	50	55	55	66	65-66	14	14	LS	High	5.5	22.5	-	-	-
SXX118	1	0.22	0.22	47	47	54	54	64	64	15	15	LS	High	5.1	28.7	-	-	-
SXX119	1	0.18	0.18	58	58	53	53	65	65-66	15	15	LS	High	5.8	34.2	-	-	-
SXX205	3	0.77	0.67-0.87	69	62-71	71	71	83	77-87	16	16-17	LS	High	5.1	100	1-loop	2	-
SXX203	3	0.58	0.32-0.75	69	68-71	73	73	88	85-90	15	14-15	LS	High	5.0	100	1-loop	2	-
SXX201	2	0.67	0.64-0.70	70	70-71	74	74	87	87	15	15-16	LS	High	5.0	99.4	1-loop	2	-
SXX204	1	1.39	1.39	67	67	74	74	88	87-88	14	14	LS	High	5.0	99.3	1-loop	2	-
SXX206	1	1.52	1.52	78	78	74	74	86	86-87	16	16	LS	High	5.1	100	1-loop	2	-
SXX221	1	1.10	1.10	73	73	-	-	86	83-89	15	15	LS	High	5.8	100	1-loop	2	-
SXX219	1	1.59	1.59	71	71	-	-	82	81-84	16	16	LS	High	5.8	98.8	1-loop	2	-
SXX218	1	1.64	1.64	71	71	-	-	85	81-88	16	16	LS	High	5.8	100	1-loop	2	-
SXX220	1	1.60	1.53-1.66	70	68-71	-	-	86	82-89	15	15-16	LS	High	5.8	100	1-loop	2	-
SXX511	2	1.70	1.56-1.84	73	71-76	74	74	83	83	14	14-15	LS	High	5.4	100	1-loop	2	-
SXX512	1	1.20	1.20	66	66	74	74	87	87	14	14	LS	High	5.4	100	1-loop	2	-
SXX509	1	1.06	1.06	69	69	73	73	87	86-89	15	15	LS	High	5.5	99.8	1-loop	2	-
SXX216	1	0.89	0.89	68	68	72	72	81	79-83	15	15	LS	High	5.4	99.8	1-loop	2	-
SXX211	1	1.63	1.63	79	79	-	-	85	85-86	14	14	LS	High	5.5	100	1-loop	2	-
SXX515	1	1.56	1.56	76	76	73	73	88	88	15	15	LS	High	5.5	100	1-loop	2	-
SXX216	1	1.96	1.96	67	67	74	74	89	88-91	14	14	LS	High	5.4	99.8	1-loop	2	-
SXX214	1	2.39	2.39	76	76	75	75	89	88-89	14	14	LS	High	5.3	100	1-loop	2	-
SXX213	1	1.70	1.70	72	72	75	75	88	88	16	16	LS	High	5.4	100	1-loop	2	-
SXX209	2	1.84	1.84	70	70-71	74	74	-	-	16	16	LS	High	5.4	99.8	1-loop	2	-
SXX217	2	1.84	1.84	70	68-73	72	72	-	-	15	14-15	LS	High	5.4	100	1-loop	2	-
SXX401	1	2.05	2.05	71	71	70	70	90	88-92	15	15	LS	High	5.2	99.2	1-loop	2	-
SXX416	1	1.75	1.75	68	68	75	75	90	89-92	17	17	LS	High	5.8	99.0	1-loop	2	-
SXX419	1	1.66	1.66	72	72	74	74	91	88-94	16	16	LS	High	5.8	100	1-loop	2	-
SXX421	1	1.93	1.93	67	67	75	75	78	77-80	16	16	LS	High	5.8	99	1-loop	2	-
SXX417	1	1.85	1.85	70	70	75	75	88	82-93	15	15	LS	High	5.8	100	1-loop	2	-
SXX422	1	2.02	2.02	72	72	75	75	90	89-90	15	15	LS	High	5.5	100	1-loop	2	-
SXX404	1	0.80	0.80	79	79	74	74	89	88-89	17	17	LS	High	5.0	100	1-loop	2	-
SXX402	1	0.72	0.72	72	72	77	77	89	87-92	16	16	LS	High	5.1	99.5	1-loop	2	-
SXX405	1	0.89	0.89	73	73	72	72	90	87-93	14	14	LS	High	5.1	99.5	1-loop	2	-
SXX411	1	1.84	1.84	75	75	75	75	92	89-94	15	15	LS	High	5.4	100	1-loop	2	-
SXX412	1	2.54	2.54	76	76	71	71	92	92	14	14	LS	High	5.3	100	1-loop	2	-
SXX413	1	1.79	1.79	52	52	75	75	90	90-91	11	11	LS	High	5.4	99.6	1-loop	2	-
SXX409	1	1.84	1.84	71	71	75	75	90	90	15	15	LS	High	5.4	100	1-loop	2	-
SXX420	1	1.66	1.66	75	75	74	74	89	88-90	16	16	LS	High	5.8	100	1-loop	2	-

Table L-2 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE SPRAY TOWER SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxid. Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
SXX304	1	0.15	0.15	59	59	69	69	71	69-72	15	15	LS	High	5.0	29.8	-	-	-
SXX305	1	0.15	0.15	37	37	56	56	64	62-65	14	14	LS	High	5.1	40.6	-	-	-
SXX306	1	0.33	0.33	63	63	58	58	73	69-77	14	14	LS	High	5.1	23.3	-	-	-
SXX312	1	0.20	0.20	48	48	55	55	71	71	15	15	LS	High	5.4	38.8	-	-	-
SXX315	1	0.10	0.10	49	49	53	53	66	63-69	16	16	LS	High	5.7	29.7	-	-	-
SAA103	2	0.16	0.14 -0.17	47	40-54	54	54	71	68-79	14	14-15	LS	High	5.0	40.0	-	-	810
SAA107	1	0.13	0.13	42	42	54	54	70	65-72	14	14	LS	High	5.5	36.1	-	-	835
SAA102	1	0.18	0.18	43	43	52	52	67	66-67	15	15	LS	High	5.4	26.8	-	-	970
SAA105	1	0.23	0.23	61	61	59	59	76	75-77	16	16	LS	High	5.0	43.3	-	-	860
SAA108	1	0.49	0.49	63	63	73	73	90	87-94	16	16	LS	High	4.5	85.5	-	-	945
SAA116	1	0.41	0.41	57	57	58	58	74	71-82	13	13	LS	High	5.0	62.0	-	-	1355
SAA114	1	0.09	0.09	43	43	62	62	73	70-76	15	15	LS	High	5.0	62.8	-	-	1325
SAA118	1	0.07	0.07	43	43	47	47	61	59-62	15	15	LS	High	5.1	60.9	-	-	2000
SAA121	1	0.40	0.40	62	62	72	72	76	69-80	16	16	LS	High	4.5	95.7	-	-	1735
SAA124	1	0.03	0.03	24	24	43	43	60	57-62	14	14	LS	High	5.0	44.3	-	-	1915
SAA122	1	0.12	0.12	49	49	53	53	61	61	16	16	LS	High	5.1	60.0	-	-	2130
SAA223	1	0.70	0.70	60	60	68	68	88	87-89	13	13	LS	High	4.7	99.8	1-loop	2	2100
SAA222	1	0.59	0.59	66	66	70	70	89	87-91	15	15	LS	High	5.1	100	1-loop	2	2135
SAA218	1	0.58	0.58	71	71	71	71	89	89-90	16	16	LS	High	5.1	100	1-loop	2	2150
SAA220	1	0.53	0.53	68	68	71	71	89	87-90	15	15	LS	High	5.1	100	1-loop	2	1900
SAA227	1	0.49	0.49	82	82	72	72	79	68-89	16	16	LS	High	5.0	100	1-loop	2	2220
SAA226	1	0.51	0.51	71	71	71	71	85	83-88	17	17	LS	High	4.6	99.6	1-loop	2	1960
SAA211	2	0.71	0.53-0.89	75	68-81	72	72	86	79-93	15	15	LS	High	4.7	99.8	1-loop	2	1440
SAA209	1	0.53	0.53	72	72	76	76	89	84-91	15	15	LS	High	4.9	100	1-loop	2	1385
SAA210	1	0.82	0.82	67	67	76	76	86	86	16	16	LS	High	5.4	100	1-loop	2	1415
SAA216	1	0.57	0.57	68	68	74	74	91	89-92	16	16	LS	High	5.0	99.6	1-loop	2	1325
SAA213	1	0.62	0.62	73	73	76	76	83	79-85	15	15	LS	High	5.4	95.6	1-loop	2	1360
SAA230	1	0.70	0.70	73	73	76	76	80	75-86	16	16	LS	High	5.4	99.5	1-loop	2	1215
SAA215	2	0.45	0.24-0.65	70	69-70	72	72	90	85-94	16	15-16	LS	High	4.5	99.6	1-loop	2	1195
SAA231	1	0.23	0.23	77	77	74	74	85	82-88	17	17	LS	High	4.6	100	1-loop	2	1180
SAA233	1	0.55	0.55	67	67	74	74	85	80-91	15	15	LS	High	5.1	100	1-loop	2	1210
SAA234	1	0.54	0.54	74	74	76	76	89	84-92	16	16	LS	High	5.0	100	1-loop	2	1275
SAA203	1	0.52	0.52	66	66	73	73	83	78-87	15	15	LS	High	5.0	100	1-loop	2	835
917-1A	53	0.59	0.37-1.13	71	65-81	73	66-76	86	82-88	15	14-16	LS	High	5.1	99.8	1-loop	2	1520

Table L-3

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxid. Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
976-2A	3	0.65	0.53-0.87	59	-	72	71-74	63	60-66	15	14.2-15.6	L	High	7.0	16	-	-	-
976-2B	2	1.44	1.40-1.47	48	-	67	66-70	63	60-66	8	7.5-8.7	L	High	7.0	12	-	-	-
977-2A	6	1.89	1.66-2.96	57	-	68	64-72	61	57-64	8	7.4-8.6	L	High	6.9	10	-	-	420
978-2A	5	1.55	1.26-1.89	49	-	56	48-67	59	57-62	8	6.8-9.4	L	High	7.0	21	-	-	-
979-2A	3	1.48	1.25-1.84	54	-	54	44-64	55	52-57	8	7.2-9.0	L	High	7.1	14	-	-	620
980-2A	4	1.53	1.34-1.75	55	36-38	55	44-70	57	53-61	8	7.9-8.9	L	High	6.9	10	-	-	1305
981-2A	1	1.70	1.70	65	65	81	81	60	59-61	8	7.8-8.6	L	High	6.9	9	-	-	1235
951-2A	1	0.92	0.92	58	58	61	61	61	59-62	8	8.5-9.1	L	High	7.0	47	1-loop	1	1215
951-2B	3	1.58	1.53-1.61	58	50-69	60	54-64	74	72-76	8	7.2-8.8	L	High	5.5	88	1-loop	1	1230
951-2C	2	1.65	1.49-1.80	59	57-60	62	56-69	74	72-76	8	7.6-8.8	L	High	5.0	95	1-loop	1	1270
951-2D	3	1.70	1.53-1.89	52	52	60	58-60	71	69-73	8	7.4-8.2	L	High	4.6	96	1-loop	1	1260
951-2E	1	1.68	1.68	57	57	57	57	72	70-74	8	7.1-8.5	L	High	5.0	98	1-loop	1	1330
625-2A	33	1.40	0.68-2.07	49	38-57	56	49-63	57	52-63	8	7.0-9.2	L	High	8.0	16	-	-	-
927-2A	8	0.1	0.1-0.2	48	42-57	55	49-64	62	56-68	15	14-16	LS	High	5.3	19	-	-	350
928-2A	3	0.2	0.2-0.3	61	54-69	54	52-56	59	56-62	15	13-17	LS	High	5.4	14	-	-	1600
929-2A	5	0.2	0.1-0.2	55	50-61	54	50-56	59	56-62	15	14-15	LS	High	5.5	10	-	-	885
930-2A	3	0.2	0.1-0.3	57	54-59	56	54-57	58	54-62	15	14-16	LS	High	5.6	13	-	-	700
931-2A	4	0.2	0.1-0.2	47	42-51	56	55-59	62	56-68	15	13-15	LS	High	5.0	21	-	-	840
932-2A	19	0.2	0.1-0.3	52	43-69	56	52-70	58	52-63	15	14-16	LS	High	5.3	21	-	-	1620
933-2A	11	0.18	0.08-0.43	48	39-60	53	52-55	57	53-61	14	13-15	LS	High	5.5	24	-	-	-
901-2H	2	0.81	0.69-0.93	60	63-57	67	66-67	77	74-80	15	14-16	LS	High	5.3	99.0	1-loop	1	1575
901-2I	2	0.84	0.83-0.85	66	71-61	65	63-67	78	75-81	15	14-16	LS	High	5.3	98.5	1-loop	1	1530
902-2A	1	0.85	0.85	66	66	68	68	78	77-78	15	13-16	LS	High	5.2	98.6	1-loop	1	1560
902-2B	1	0.97	0.97	68	68	64	64	76	74-79	15	14-15	LS	High	5.2	97.5	1-loop	1	1630
903-2A	1	2.69	2.69	68	68	68	68	78	76-80	14	13-15	LS	High	5.3	99.1	1-loop	2	1550
903-2B	3	1.15	0.77-1.64	74	66-80	72	71-74	88	86-91	15	14-16	LS	High	5.4	99.5	1-loop	2	1530
TAA001	1	0.79	0.79	80	80	72	72	88	88	15	15	LS	High	5.7	100	1-loop	2	648
TAA002	1	1.05	1.05	68	68	73	73	89	86-92	14	14	LS	High	5.7	99.6	1-loop	2	651
TAA005	1	1.42	1.42	68	68	73	73	89	88-90	15	15	LS	High	5.9	99.6	1-loop	2	624
TAA007	1	1.25	1.25	68	68	73	73	85	84-86	14	14	LS	High	5.7	99.5	1-loop	2	595
TAA009	1	1.02	1.02	73	73	72	72	86	84-87	15	15	LS	High	5.8	99.6	1-loop	2	646
TAA011	1	1.70	1.70	66	66	72	72	91	90-93	15	15	LS	High	6.0	99.8	1-loop	2	644
TAA013	3	0.11	0.05-0.16	44	40-48	61	50-69	59	56-60	15	14-15	LS	High	6.0	43.6	-	-	667
TAA014	1	0.11	0.11	48	48	47	47	-	-	15	15	LS	High	6.1	36.5	-	-	529
TAA015	2	0.12	0.12	46	46-47	47	46-48	-	-	15	15	LS	High	6.0	30.3	-	-	1389
TAA016	1	0.16	0.16	42	42	52	52	-	-	15	15	LS	High	6.0	25.4	-	-	1309
TAA017	1	1.25	1.25	78	78	73	73	85	84-86	15	15	LS	High	6.1	97.3	1-loop	2	1176
TAA019	1	1.04	1.04	86	86	72	72	79	79-80	15	15	LS	High	6.0	99.1	1-loop	2	1423
TAA022	1	1.03	1.03	68	68	72	72	87	87	15	15	LS	High	6.0	99.9	1-loop	2	1144
TAA023	1	1.04	1.04	73	73	72	72	85	85-86	15	15	LS	High	5.8	99.8	1-loop	2	1384
TAA026	1	1.03	1.03	72	72	69	69	87	85-89	14	14	LS	High	5.9	99.8	1-loop	2	1335
TAA027	1	1.03	1.03	67	67	72	72	86	84-88	15	15	LS	High	5.9	99.2	1-loop	2	1247
TAA028	1	1.02	1.02	65	65	68	68	86	85-87	15	15	LS	High	5.8	99.7	1-loop	2	2122
TAA029	1	1.02	1.02	67	67	68	68	85	82-88	14	14	LS	High	6.0	99.6	1-loop	2	1911
TAA031	1	1.29	1.03-1.55	72	67-76	70	69-70	86	84-89	14	14	LS	High	5.9	99.8	1-loop	2	2088

Table L-3 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA SYSTEM

Run No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxid. Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
TAA034	1	0.88	0.88	60	60	72	72	-	-	13	13	LS	High	5.8	100	1-loop	2	1916
TAA035	1	0.88	0.88	72	72	72	72	88	87-89	16	16	LS	High	5.8	100	1-loop	2	2065
TAA037	1	0.90	0.90	73	73	71	71	88	87-89	14	14	LS	High	5.8	99.5	1-loop	2	2099
TAA039	1	1.53	1.53	78	78	71	71	83	83	15	15	LS	High	5.7	100	1-loop	2	2025
TAA040	1	1.04	1.04	72	72	73	73	86	86	14	14	LS	High	5.7	99.4	1-loop	2	2245
TAA042	1	1.01	1.01	65	65	69	69	88	88	15	15	LS	High	5.7	99.7	1-loop	2	2284
TAA043	2	0.15	0.10-0.21	48	38-59	70	70	52	50-55	14	13-15	LS	High	5.9	30.4	-	-	1955
TAA044	1	0.40	0.4	57	57	65	65	50	49-51	15	15	LS	High	5.9	33.7	-	-	2128
904-2A	2	1.74	1.55-1.93	62	59-66	71	70-72	85	79-89	15	14-16	LS	High	5.5	98.0	1-loop	1	-
904-2B	2	1.34	1.19-1.49	68	67-68	69	68-70	86	70-89	15	15-16	LS	High	5.4	99.1	1-loop	1	-
904-2C	2	1.16	1.05-1.27	68	65-72	70	70	88	85-89	14	14-15	LS	High	5.3	99.4	1-loop	1	-
904-2D	3	0.98	0.68-1.20	65	52-77	69	69-70	81	65-81	15	15	LS	High	5.2	97.4	1-loop	1	-
904-2E	3	1.52	1.41-1.70	65	60-74	70	69-71	86	83-87	14	13-15	LS	High	5.2	99.1	1-loop	1	-
904-2F	1	1.73	1.73	70	70	71	71	86	85-86	15	13-16	LS	High	5.4	99.3	1-loop	1	-
904-2G	4	1.63	1.40-1.93	69	57-82	71	69-72	-	-	15	14-16	LS	High	5.6	99.4	1-loop	1	-
904-2H	5	1.14	0.49-1.73	61	59-66	70	69-71	-	-	15	14-16	LS	High	5.4	99.1	1-loop	1	-
904-2I	2	1.32	1.19-1.44	58	57-60	70	69-72	-	-	15	15	LS	High	5.3	99.0	1-loop	1	-
TAA301	1	2.10	2.10	65	65	71	71	-	-	15	15	LS	High	5.6	98.8	1-loop	1	-
TAA303	1	1.84	1.84	63	63	69	69	86	84-88	14	14	LS	High	5.7	98.3	1-loop	1	-
TAA306	1	1.46	1.46	60	60	67	67	85	85	15	15	LS	High	5.7	99.5	1-loop	1	-
TAA308	1	1.57	1.57	68	68	72	72	86	85-87	15	15	LS	High	5.2	99.6	1-loop	1	-
TAA310	1	1.53	1.53	77	77	69	69	86	86-87	17	17	LS	High	5.4	99.4	1-loop	1	-
TAA049	1	1.84	1.84	65	65	70	70	88	86-90	13	13	LS	High	6.1	99.5	1-loop	2	-
TAA051	1	1.75	1.75	84	84	73	73	86	85-86	17	17	LS	High	5.9	99.5	1-loop	2	-
TAA045	1	1.89	1.89	64	64	74	74	89	88-89	15	15	LS	High	6.1	99.8	1-loop	2	-
TAA307	1	1.40	1.40	64	64	73	73	85	83-87	14	14	LS	High	5.8	99.1	1-loop	1	-
TAA313	1	1.31	1.31	62	62	58	58	86	86-87	15	15	LS	High	5.4	99.6	1-loop	1	-
904-2J	1	1.04	1.04	61	61	63	63	83	83	15	14-16	LS	High	5.2	98.0	1-loop	1	-
904-2L	1	1.54	1.54	62	62	59	59	81	81-82	14	14	LS	High	5.0	98.5	1-loop	1	-
904-2N	1	0.70	0.70	54	54	65	65	80	80	14	13-15	LS	High	5.3	98.0	1-loop	1	-
904-2O	1	1.09	1.09	63	63	62	62	86	86	15	15	LS	High	5.0	98.1	1-loop	1	-
904-2Q	1	0.23	0.23	52	52	60	60	71	70-72	15	15	LS	High	5.3	74.7	1-loop	1	-
904-2S	1	1.05	1.05	65	65	67	67	87	85-89	16	15-16	LS	High	5.4	99.0	1-loop	1	-
904-2T	1	0.58	0.58	70	70	72	72	82	78-85	15	14-15	LS	High	5.4	98.4	1-loop	1	-
905-2A	1	0.14	0.14	48	48	66	66	59	57-61	15	15	LS	High	5.4	35	-	-	-
905-2C	1	0.40	0.40	49	49	65	65	64	63-64	16	15-17	LS	High	5.4	59.0	1-loop	1	-
905-2F	1	0.48	0.48	48	48	65	65	68	64-73	15	15	LS	High	5.5	67.0	1-loop	1	-
905-2G	1	0.19	0.19	55	55	64	64	67	66-69	16	16	LS	High	5.6	69.0	1-loop	1	-
905-2H	1	0.19	0.19	47	47	61	61	70	69-72	15	15	LS	High	5.4	66.0	1-loop	1	-
905-2I	1	0.36	0.36	59	59	65	65	68	66-70	15	15	LS	High	5.5	65.0	1-loop	1	-
TAA053	1	1.35	1.35	71	71	72	72	86	84-88	14	14	LS	High	5.6	96.3	1-loop	2	707
TAA054	1	1.66	1.66	66	66	73	73	85	85	15	15	LS	High	5.1	98.7	1-loop	2	761
TAA055	1	0.62	0.62	75	75	71	71	83	82-84	14	14	LS	High	4.6	99.4	1-loop	2	667
TAA056	1	1.01	1.01	73	73	67	67	86	83-89	15	15	LS	High	5.3	100	1-loop	2	1247
TAA057	1	1.20	1.20	76	76	68	68	83	82-83	15	15	LS	High	5.5	100	1-loop	2	1249

Table L-3 (continued)

SETTLING AND FUNNEL TEST RESULTS FOR THE TCA SYSTEM

Run[1] No.	Number of Samples	Initial Settling Rate, cm/min		Ultimate Settled Solids wt%		Funnel Test Cake Solids wt%		Solids Discharged, wt%		Initial Solids, wt%		Alkali	Fly Ash Loading	Inlet pH	Sample Oxidation Mole %	Oxidation Scheme	No. of Tanks in Oxid. Loop	Adipic Acid Concentration ppm
		avg.	range	avg.	range	avg.	range	avg.	range	avg.	range							
TAA058	1	0.72	0.72	74	74	68	68	86	84-88	15	15	LS	High	5.3	99.6	1-loop	2	1409
TAA059	1	0.64	0.64	79	79	69	69	80	80	15	15	LS	High	5.3	99.5	1-loop	2	1273
TAA061	1	0.78	0.78	74	74	73	73	86	85-86	15	15	LS	High	5.2	98.6	1-loop	2	1497
TAA062	1	1.15	1.15	70	70	73	73	89	86-91	16	16	LS	High	5.4	99.5	1-loop	2	2102
TAA064	2	1.27	0.91-1.63	66	65-68	67	67	88	86-90	13	13-14	LS	High	4.6	100	1-loop	2	2109
906-2A	4	1.34	1.03-1.55	67	61-76	70	69-71	86	81-90	15	14-17	LS	High	5.7	99.2	1-loop	2	830-2115
934-2E	1	0.31	0.31	37	37	39	39	71	66-80	9.9	9.3-11.5	LS	Low	5.0	38.3	-	-	1540
934-2F	3	0.64	0.62-0.67	46	42-50	45	44-47	87	84-88	9.3	8.7-10.1	LS	Low	4.6	50.3	-	-	1525
934-2D	2	0.37	0.30-0.44	36	33-39	43	43-44	74	71-76	9.9	9.7-10.4	LS	Low	5.4	23.2	-	-	1565
934-2G	2	0.30	0.25-0.34	34	32-37	39	37-41	80	76-78	9.6	9.3-9.9	LS	Low	5.0	26.9	-	-	1575
934-2H	2	0.51	0.45-0.57	36	35-36	34	34	78	78-81	10.3	9.7-10.4	LS	Low	5.0	25.1	-	-	2475
907-2A	2	1.02	0.81-1.23	83	69-97	68	63-73	89	81-93	10.0	8.9-11.4	LS	Low	4.8	99.8	1-loop	1	2485
907-2B	1	0.75	0.75	67	67	66	66	91	89-93	10.1	9.8-10.3	LS	Low	4.8	98.4	1-loop	1	2700
907-2C	1	0.64	0.64	61	61	63	63	88	88	10.1	9.8-10.5	LS	Low	4.8	99.1	1-loop	1	2545
907-2D	1	0.86	0.86	53	53	63	63	88	81-91	10.0	9.9-11.0	LS	Low	4.9	99.8	1-loop	1	2630
907-2E	1	0.75	0.75	60	60	67	67	90	89-91	9.9	9.3-10.6	LS	Low	4.8	99.7	1-loop	1	2730
907-2F	1	0.57	0.57	64	64	69	69	88	84-93	9.9	9.6-10	LS	Low	4.8	99.7	1-loop	1	2470
907-2G	1	0.38	0.38	78	78	66	66	92	90-94	9.9	9.9-10	LS	Low	4.8	99.9	1-loop	1	2420
907-2J	2	1.18	0.57-1.78	63	61-64	66	65-66	93	90-98	10.2	5.1-11.1	LS	Low	5.0	98.8	1-loop	1	1980
907-2K	1	0.59	0.59	64	64	69	69	91	86-94	10.0	9.4-10.3	LS	Low	5.0	99.9	1-loop	1	2020
907-2L	1	0.59	0.59	72	72	62	62	88	83-92	9.8	9.5-10.0	LS	Low	5.2	99.9	1-loop	1	1790
907-2M	1	0.64	0.64	64	64	73	73	80	79-80	9.8	9.3-10.3	LS	Low	5.3	91.0	1-loop	1	1570
935-2A	2	0.09	0.06-0.11	43	39-48	46	46	51	30-57	15	15-17	LS	High	5.8	14.8	-	-	-
TGG102	1	0.10	0.10	45	45	52	52	59	57-63	12	12	LS	High	5.1	26.5	-	-	-
TGG103	1	0.08	0.08	36	36	53	53	57	55-58	13	13	LS	High	5.0	32.7	-	-	-
TGG105	1	0.08	0.08	46	46	52	52	63	60-68	14	14	LS	High	5.1	33.6	-	-	-
TGG110	1	0.16	0.16	51	51	49	49	59	57-61	12	12	LS	High	5.0	23.2	-	-	-
TGG113	1	0.08	0.08	37	37	47	47	59	58-62	13	13	LS	High	5.4	22.7	-	-	-
TGG114	1	0.05	0.05	41	41	47	47	62	62-63	16	16	LS	High	5.4	21.1	-	-	-
TGG119	1	0.08	0.08	50	50	54	54	71	70-72	15	15	LS	High	5.4	20.0	-	-	-
TGG129	1	0.05	0.05	38	38	46	46	73	73	15	15	LS	High	5.3	26.0	-	-	-
TGG101	1	0.06	0.06	39	39	47	47	52	51-53	13	13	LS	High	5.0	21.8	-	-	-
TGG120	1	0.49	0.49	63	63	50	50	64	55-73	14	14	LS	High	5.4	26.3	-	-	-
TGG116	1	0.09	0.09	49	49	50	50	71	68-74	13	13	LS	High	5.4	25.4	-	-	-
TGG130	1	0.07	0.07	42	42	50	50	63	62-64	15	15	LS	High	5.8	13.6	-	-	-

(1) Run 935-2A, and the TGG runs were made with Glitsch Grid packing instead of spheres.

APPENDIX M

FLUE GAS CHARACTERIZATION TEST DATA

This Appendix presents the results of routine mass loading, particle size distributions, and particle mass penetration tests performed during the reporting period.

Table M-1

VENTURI/SPRAY TOWER MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash Loading	ΔP, in. H_2O		Gas Rate, acfm @ 300°F	Slurry Rate, gpm		Additive
							Venturi	Total[(1)]		V	ST	
823-1A	05/22/78	4.26	0.038	99.1	LS	High	9.0	12.0	18,000	600	1600	MgO
	05/23/78	3.67	0.054	98.5	LS	High	9.0	11.9	18,000	600	1600	MgO
825-1A	06/01/78	6.20	0.046	99.3	LS	High	9.0	11.8	18,000	600	1600	MgO
951-1A	07/05/78	4.35	0.042	99.0	L	High	9.0	16.4	35,000	600	1600	None
901-1A	07/19/78	4.78	0.032	99.3	LS	High	9.0	17.1	35,000	600	1600	None
903-1A	08/29/78	4.04	0.033	99.2	LS	High	8.8	14.3	34,500	600	0	Adipic
	08/30/78	5.54	-	-	LS	High	9.4	14.9	34,500	600	0	Adipic
	08/31/78	2.92	0.044	98.5	LS	High	9.0	15.0	34,700	600	0	Adipic
	08/31/78	3.30	-	-	LS	High	8.8	14.7	34,700	600	0	Adipic
	09/01/78	-	0.041	-	LS	High	9.0	14.9	34,700	600	0	Adipic
904-1A	09/07/78	3.78	0.034	99.1	LS	High	8.7	10.0	17,500	600	0	Adipic
907-1A	10/24/78	5.68	0.063	98.9	LS	High	8.7	15.8	33,500	600	1600	Adipic
	10/25/78	4.41	0.051	98.8	LS	High	8.9	15.9	33,500	600	1600	Adipic
	10/30/78	3.20	0.038	98.8	LS	High	8.0	15.0	33,500	600	1600	Adipic
	10/31/78	3.22	0.031	99.0	LS	High	8.7	15.5	33,500	600	1600	Adipic
	11/01/78	3.76	0.029	99.2	LS	High	8.2	14.8	30,000	600	1600	Adipic
907-1B	11/14/78	4.29	0.043	99.0	LS	High	9.7	15.5	35,000	600	1600	Adipic
827-1A	02/27/79	2.45	-	-	LS	High	8.9	17.3	35,000	600	1500	None
910-1A	04/16/79	-	0.039	-	LS	High	8.4	14.3	33,000	600	1600	Adipic
	04/16/79	2.40	0.046	98.1	LS	High	9.0	15.5	35,000	600	1600	Adipic
911-1A	04/23/79	3.05	0.042	98.7	LS	High	6.9	11.9	32,000	600	1600	Adipic
	04/23/79	3.60	0.048	98.7	LS	High	7.0	-	32,000	600	1600	Adipic
912-1A	04/24/79	3.11	0.041	98.7	LS	High	7.7	13.5	33,500	600	1600	Adipic
	04/24/79	2.81	0.042	98.5	LS	High	7.3	12.7	32,500	600	1600	Adipic
VAA103	05/01/79	2.43	0.049	98.0	L	High	9.2	11.2	27,500	600	0	Adipic
	05/01/79	2.50	0.034	98.6	L	High	7.5	9.7	27,500	600	0	Adipic

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(1) Excluding mist eliminator pressure drop

Table M-1 (continued)

VENTURI/SPRAY TOWER MASS LOADING TEST RESULTS

Run No.	Date	Inlet gr/dscf	Outlet gr/dscf	Removal %	Alkali	Fly Ash Loading	ΔP, in. H_2O		Gas Rate, acfm @ 300°F	Slurry Rate, gpm		Additive
							Venturi	Total[(1)]		V	ST	
VAA001	07/13/79	3.11	0.033	98.9	LS	High	9.1	13.8	35,000	600	1200	ADIPIC
VAA015	08/02/79	4.47	0.030	99.3	LS	High	8.9	10.3	20,000	600	1200	ADIPIC
VAA018	08/31/79	3.10	0.060	98.0	LS	High	8.9	14.5	35,000	600	1600	ADIPIC
VAA039	09/19/79	4.41	0.063	98.5	LS	High	2.3	5.4	27,500	125	1200	ADIPIC
VAA048	10/01/79	5.13	0.041	99.2	LS	High	9.0	14.7	35,000	600	800	ADIPIC
VAA035	10/02/79	3.15	0.041	98.7	LS	High	9.2	14.9	35,000	600	800	ADIPIC
VAA021	10/26/79	3.55			LS	High	8.9	13.1	35,000	140	1200	ADIPIC
VAA220	11/16/79	2.55	0.034	98.6	LS	High	2.7	6.9	35,000	140	1600	ADIPIC
VAA226	11/29/79	2.37	0.026	98.9	LS	High	4.1	8.6	35,000	140	400	ADIPIC
VAA224	12/18/79	4.65	0.048	98.9	LS	High	3.8	7.9	35,000	140	1600	ADIPIC
926-1A	12/19/79	2.37	0.031	98.6	LS	High	8.8	14.7	35,000	600	1600	ADIPIC
	12/20/79	3.06			LS	High	8.9	14.4	35,000	600	1600	ADIPIC
926-1G	01/07/80	3.31	0.038	98.8	LS	High	8.8	15.0	35,000	600	1600	ADIPIC
	01/10/80	3.21	0.043	98.6	LS	High	9.1	15.0	35,000	600	1600	ADIPIC
926-1B	01/21/80	6.66	0.055	99.1	LS	High	8.9	15.5	35,000	600	1600	ADIPIC
926-1C	01/28/80	5.57	0.038	99.3	LS	High	9.0	15.7	35,000	600	1600	ADIPIC
927-1B	02/22/80	4.72	0.056	98.8	LS	High	5.9	7.9	20,000	600	--	ADIPIC
927-1C	02/25/80	4.66	0.044	99.0	LS	High	5.8	7.8	19,800	600	--	ADIPIC
927-1E	02/28/80	4.58	0.031	99.3	LS	High	8.1	13.7	35,000	600	--	ADIPIC
926-1H	04/04/80	2.58	0.045	98.2	LS	High	9.3	12.9	30,000	600	--	ADIPIC
915-1A	04/14/80	3.86	0.040	98.9	LS	High	8.8	15.9	35,000	600	1600	ADIPIC
915-1B	04/15/80	3.43	0.039	98.8	LS	High	9.0	16.6	35,000	600	1600	ADIPIC
915-1C	04/18/80	5.01	0.036	99.3	LS	High	8.7	15.1	35,000	600	1600	ADIPIC
916-1B	04/29/80	3.35	0.042	98.7	LS	High	6.0	10.4	30,000	600	1200	ADIPIC
	04/30/80	4.61	0.045	99.0	LS	High	5.4	10.2	30,000	600	1200	ADIPIC
916-1F	05/20/80	2.53	0.037	98.5	LS	High	6.0	10.8	30,000	600	1200	ADIPIC
	05/21/80	2.87	0.053	98.1	LS	High	6.2	11.0	30,000	600	1200	ADIPIC
916-1G	05/22/80	3.26	0.040	98.7	LS	High	6.1	10.8	30,000	600	1200	ADIPIC

(1) Excluding mist eliminator pressure drop

Table M-2
SPRAY TOWER MASS LOADING TEST RESULTS

Run No.	Date	Inlet gr/dscf	Outlet gr/dscf	Removal %	Alkali	Fly ash Loading	System ΔP, in H_2O (1)	Gas Rate, acfm @ 300^0F	Slurry Rate, gpm	Additive
SXX103	06/23/80	3.69	0.067	98.1	LS	High	-	35,000	1600	none
SXX205	07/10/80	4.39	0.096	97.7	LS	High	2.2	35,000	1600	none
	07/11/80	5.37	0.071	98.6	LS	High	2.2	35,000	1600	none
SXX203	07/15/80	4.26	0.086	97.9	LS	High	1.0	27,500	1600	none
SXX202	07/16/80	4.51	0.098	97.7	LS	High	2.2	35,000	1200	none
SXX207	07/17/80	4.09	0.075	98.1	LS	High	1.0	20,000	1600	none
SXX203	07/21/80	4.42	0.088	97.9	LS	High	1.2	35,000	800	none
SXX220	07/22/80	5.22	0.080	98.4	LS	High	1.6	35,000	1200	none
	07/23/80	4.24	0.080	98.0	LS	High	1.5	35,000	1200	none
SXX514	07/28/80	4.05	0.108	97.2	LS	High	1.3	35,000	800	none
SXX216	07/29/80	3.52	0.064	98.1	LS	High	1.6	35,000	1200	none
SXX203	07/30/80	3.23	0.064	97.9	LS	High	0.3	20,000	1600	none
SXX208	07/31/80	3.87	0.074	98.0	LS	High	0.2	20,000	1600	none
SXX211	08/01/80	2.87	0.066	97.6	LS	High	0.9	27,500	1600	none
SXX301	09/26/80	2.69	0.076	97.1	LS	High	1.7	20,000	2400	none
SXX416	09/22/80	4.78	0.062	98.6	LS	High	2.9	35,000	2400	none
SXX308	09/29/80	4.07	0.053	98.6	LS	High	1.7	20,000	1800	none
SAA103	10/14/80	3.12	0.054	98.2	LS	High	3.2	35,000	2400	ADIPIC
SAA102	10/17/80	5.54	0.055	99.0	LS	High	1.3	27,500	1200	ADIPIC
SAA109	10/23/80	3.45	0.063	98.1	LS	High	1.5	27,500	1200	ADIPIC
SAA114	10/27/80	3.44	0.051	98.5	LS	High	2.7	35,000	2400	ADIPIC
SAA109	10/28/80	3.38	0.062	98.1	LS	High	1.4	27,500	1200	ADIPIC
SAA115	10/29/80	3.03	0.053	98.2	LS	High	1.9	27,500	2400	ADIPIC
SAA119	10/30/80	3.62	0.058	98.4	LS	High	1.5	27,500	1200	ADIPIC
SAA215	11/25/80	5.20	0.054	98.9	LS	High	2.0	27,500	2400	ADIPIC
917-1A	12/30/80	4.35	0.063	98.5	LS	High	3.0	34,500	2400	ADIPIC

(1) Excluding mist eliminator pressure drop

Table M-2 (continued)

SPRAY TOWER MASS LOADING TEST RESULTS

Run No.	Date	Inlet gr/dscf	Outlet gr/dscf	Removal %	Alkali	Fly Ash Loading	System ΔP, in $H_2O^{(1)}$	Gas Rate acfm @ 300°F	Slurry Rate, gpm	Additive
917-1A	01/08/81	3.89	0.048	98.7	LS	High	3.0	35,000	2400	Adipic
	01/09/81	4.26	0.061	98.5	LS	High	3.0	35,000	2400	Adipic
	01/12/81	3.80	0.048	98.7	LS	High	2.5	30,000	2400	Adipic
	01/14/81	4.80	0.052	98.9	LS	High	3.1	35,000	2400	Adipic
	01/15/81	5.22	0.047	99.1	LS	High	2.4	30,000	2400	Adipic
	02/12/81	4.03	0.058	98.5	LS	High	2.4	30,000	2400	Adipic
	02/23/81	5.76	0.056	99.0	LS	High	2.4	30,000	2400	Adipic
	02/23/81	6.15	0.057	99.1	LS	High	2.4	30,000	2400	Adipic
	03/05/81	4.34	0.061	98.6	LS	High	2.2	30,000	2400	Adipic
	03/09/81	3.79	0.063	98.3	LS	High	2.4	30,000	2400	Adipic
	03/10/81	4.82	0.060	98.7	LS	High	2.3	30,000	2400	Adipic
	03/13/81	4.41	0.058	98.6	LS	High	2.3	30,000	2400	Adipic
SAA201	03/17/81	4.69	0.062	98.6	LS	High	3.0	35,000	2400	Adipic
	03/18/81	4.19	0.074	98.2	LS	High	1.8	27,600	1200	Adipic
SAA264	03/23/81	4.49	0.074	98.3	LS	High	2.6	35,000	1800	Adipic
SAA265	03/24/81	3.61	0.078	97.8	LS	High	2.4	35,000	1800	Adipic
SAA258	03/31/81	3.58	0.063	98.2	LS	High	2.7	35,000	1800	Adipic
SAA251	04/01/81	3.82	0.056	98.5	LS	High	1.5	23,400	1200	Adipic
SAA256	04/02/81	2.99	0.091	96.9	LS	High	1.2	23,400	1200	Adipic

(1) Excluding mist eliminator pressure drop

Table M-3

TCA MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dsf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash Loading	System ΔP, (1) in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm	Additive	Total Sphere Bed Height, in.
821-2A	06/07/78	-	0.130	-	LS	High	6.5	30,000	1200	MgO	15
624-2A	06/09/78	4.15	-	-	L	High	6.7	30,000	900	MgO	15
	06/14/78	-	0.109	-	L	High	6.8	30,000	900	MgO	15
926-2A	07/11/78	4.15	0.049	98.8	LS	High	8.0	30,000	1200	None	15
976-2A	07/13/78	-	0.090	-	L	High	7.9	30,000	1200	None	15
	07/17/78	4.45	0.045	99.0	L	High	8.2	30,000	1200	None	15
	07/18/78	4.22	0.041	99.0	L	High	7.9	30,000	1200	None	15
976-2B	07/20/78	4.08	0.043	98.9	L	High	7.7	30,000	1200	None	15
	07/24/78	5.29	-	-	L	High	8.0	30,000	1200	None	15
927-2A	08/11/78	2.08	0.093	95.5	LS	High	7.5	30,000	1200	Adipic	15
	08/14/78	3.83	0.066	98.3	LS	High	7.5	30,000	1200	Adipic	15
	08/15/78	-	0.073	-	LS	High	7.5	30,000	1200	Adipic	15
	08/16/78	3.57	-	-	LS	High	7.2	30,000	1200	Adipic	15
	08/17/78	4.62	0.064	98.6	LS	High	7.3	30,000	1200	Adipic	15
928-2A	08/23/78	3.31	0.054	98.4	LS	High	7.2	30,000	1200	Adipic	15
	08/24/78	2.56	0.049	98.1	LS	High	7.3	30,000	1200	Adipic	15
	08/25/78	3.23	0.062	98.1	LS	High	7.2	30,000	1200	Adipic	15
932-2A	10/26/78	4.70	0.037	99.2	LS	High	8.3	29,000	1200	Adipic	15
	10/27/78	4.89	0.060	98.8	LS	High	8.4	30,000	1200	Adipic	15
625-2A	11/16/78	5.20	-	-	L	High	11.0	30,000	1450	None	15
	11/20/78	3.77	0.034	99.1	L	High	8.3	25,500	1450	None	15
	11/28/78	3.38	0.033	99.0	L	High	9.4	30,000	1450	None	15
	12/01/78	4.24	0.034	99.2	L	High	11.1	30,000	1450	None	15

(1) Excluding mist eliminator pressure drop

Table M-3 (continued)

TCA MASS LOADING TEST RESULTS

Run No.	Date	Inlet, gr/dscf	Outlet, gr/dscf	Removal, %	Alkali	Fly Ash Loading	System ΔP, (1) in, H_2O	Gas Rate, acfm @ 300^oF	Slurry Rate, gpm	Additive	Total Sphere Bed Height, in.
933-2A	02/06/79	2.24	0.075	96.7	LS	High	8.8	30,000	1200	None	15
978-2A	02/12/79	3.94	0.079	98.0	L	High	9.3	30,000	1200	None	15
979-2A	02/20/79	3.12	-	-	L	High	9.5	30,000	1200	Adipic	15
981-2A	03/12/79	-	0.040	-	L	High	7.9	30,000	1200	Adipic	15
951-2A	03/19/79	4.22	0.039	99.1	L	High	9.0	30,000	1200	Adipic	15
951-2E	04/04/79	-	0.065	-	L	High	8.9	30,000	1200	Adipic	15
	04/05/79	-	0.040	-	L	High	9.0	30,000	1200	Adipic	15
901-2A	04/10/79	2.72	0.080	97.1	LS	High	11.4	30,000	1200	Adipic	15
901-2H	04/17/79	2.42	0.045	98.2	LS	High	9.8	30,000	1200	Adipic	15
	04/17/79	3.44	-	-	LS	High	9.5	30,000	1200	Adipic	15
	04/18/79	2.16	0.037	98.3	LS	High	9.8	30,000	1200	Adipic	15
901-2J	04/25/79	2.54	0.041	98.4	LS	High	9.5	30,000	1200	Adipic	15
	04/26/79	2.08	0.043	97.9	LS	High	9.4	30,000	1200	Adipic	15
	04/26/79	2.30	0.060	97.4	LS	High	9.1	30,000	1200	Adipic	15
902-2A	04/30/79	2.47	0.061	97.5	LS	High	5.8	22,500	900	Adipic	15
	04/30/79	2.42	0.058	97.6	LS	High	5.8	22,500	900	Adipic	15
TAA010	05/22/79	2.13	0.096	95.5	LS	High	2.0	25,000	600	Adipic	0
TAA012	05/23/79	1.95	0.321	83.5	LS	High	2.7	25,000	1200	Adipic	0
	05/23/79	3.19	0.072	97.7	LS	High	2.8	25,000	1200	Adipic	0
TAA013	05/24/79	1.97	0.038	98.1	LS	High	6.9	25,000	1200	Adipic	15
	05/24/79	3.18	0.055	98.3	LS	High	7.0	25,000	1200	Adipic	15
TAA020	06/04/79	3.00	0.088	97.1	LS	High	2.3	25,000	900	Adipic	0
TAA022	06/06/79	2.06	0.058	97.2	LS	High	5.1	20,000	900	Adipic	15
	06/06/79	-	0.055	-	LS	High	5.1	20,000	900	Adipic	15
TAA041	06/19/79	2.19	0.074	96.6	LS	High	1.7	20,000	900	Adipic	0
TAA042	06/20/79	3.12	0.206	93.4	LS	High	2.2	25,000	900	Adipic	0
TAA043	06/22/79	3.08	0.048	98.4	LS	High	5.2	25,000	600	Adipic	15
904-2A	06/27/79	2.24	0.070	96.9	LS	High	8.8	30,000	1200	None	15
	06/28/79	3.07	0.050	98.4	LS	High	8.5	30,000	1200	None	15

(1) Excluding mist eliminator pressure drop

Table M-3 (continued)

TCA MASS LOADING TEST RESULTS

Run No.	Date	Inlet gr/dcsf	Outlet gr/dcsf	Removal %	Alkali	Fly Ash Loading	System ΔP, (1) in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm	Additive	Total Sphere Bed Height, in.
904-2C	07/09/79	3.49	0.030	99.1	LS	High	8.3	30,000	1200	None	15
904-2D	07/16/79	2.99	0.039	98.7	LS	High	8.5	30,000	1200	None	15
	07/17/79	4.20	0.032	99.2	LS	High	8.4	30,000	1200	None	15
904-2F	07/24/79	5.96	0.043	99.3	LS	High	8.2	30,000	1200	None	15
904-2H	08/06/79	5.44	0.067	98.7	LS	High	8.2	30,000	1200	None	15
TAA311	08/23/79	5.14	0.108	97.8	LS	High	6.4	25,000	900	None	15
TAA052	08/27/79	3.95	0.059	98.4	LS	High	6.0	25,000	900	None	15
905-2C	09/21/79	4.92	0.046	99.0	LS	High	9.0	30,000	1200	None	15
905-2G	09/24/79	4.00	0.042	98.9	LS	High	9.5	30,000	1200	None	15
TAA058	10/03/79	4.11	0.057	98.6	LS	High	6.6	25,000	900	ADIPIC	15
TAA060	10/04/79	4.05	0.045	98.8	LS	High	6.8	25,000	900	ADIPIC	15
906-2C	10/19/79	4.11	0.046	98.8	LS	High	7.5	25,000	1200	ADIPIC	15
934-2C	07/25/80	0.13	0.012	90.6	LS	Low	7.5	30,000	1200	ADIPIC	15
934-2E	08/12/80	0.29	0.023	91.7	LS	Low	7.7	30,000	1200	ADIPIC	15
934-2D	08/21/80	0.39	0.019	94.8	LS	Low	7.4	30,000	1200	ADIPIC	15
	08/22/80	0.32	0.012	96.1	LS	Low	7.1	30,000	1200	ADIPIC	15
	08/25/80	0.39	0.017	95.5	LS	Low	7.7	30,000	1200	ADIPIC	15
	08/26/80	0.36	0.016	95.5	LS	Low	8.6	30,000	1200	ADIPIC	15
934-2G	08/27/80	0.55	0.022	95.9	LS	Low	6.7	30,000	900	ADIPIC	15
	08/28/80	0.57	0.020	96.4	LS	Low	6.2	30,000	900	ADIPIC	15
907-2A	09/18/80	0.21	0.024	88.1	LS	Low	8.3	30,000	1200	ADIPIC	15
	09/19/80	0.46	0.028	93.6	LS	Low	9.2	30,000	1200	ADIPIC	15
907-2B	09/23/80	0.60	0.023	95.9	LS	Low	9.9	30,000	1200	ADIPIC	15
	09/24/80	0.56	0.022	96.0	LS	Low	8.2	30,000	1200	ADIPIC	15
907-2D	10/08/80	0.47	0.018	95.9	LS	Low	7.9	30,000	1200	ADIPIC	15
907-2E	10/10/80	0.83	0.038	95.2	LS	Low	5.9	25,000	1200	ADIPIC	15
907-2F	10/20/80	0.41	0.031	92.2	LS	Low	4.4	20,000	1200	ADIPIC	15
907-2G	10/21/80	0.29	0.042	85.1	LS	Low	3.3	20,000	600	ADIPIC	15
907-2J	10/31/80	0.52	0.023	95.5	LS	Low	9.9	30,000	1200	ADIPIC	15
907-2L	11/10/80	0.26	0.020	92.2	LS	Low	12.1	30,000	1200	ADIPIC	15

(1) Excluding mist eliminator pressure drop

Table M-4

GLITSCH GRID PACKING MASS LOADING TEST RESULTS(2)

Run No.	Date	Inlet gr/dscf	Outlet gr/dscf	Removal %	Alkali	Fly Ash Loading	System ΔP, (1) in. H_2O	Gas Rate, acfm @ 300°F	Slurry Rate, gpm	Additive
935-2A	12/04/80	7.95	0.036	99.5	LS	High	9.5	30,000	1200	None
	12/05/80	7.09	0.036	99.5	LS	High	10.1	30,000	1200	None
	12/09/80	6.05	0.037	99.4	LS	High	10.0	30,000	1200	None
TGG102	12/19/80	2.99	0.033	98.9	LS	High	6.3	25,000	1200	None
TGG110	12/22/80	3.25	0.048	98.5	LS	High	4.2	25,000	600	None
TGG109	12/31/80	3.67	0.254	92.8	LS	High	1.9	20,000	600	None

(1) Excluding mist eliminator pressure drop

(2) 1 Ft. Glitsch Grid

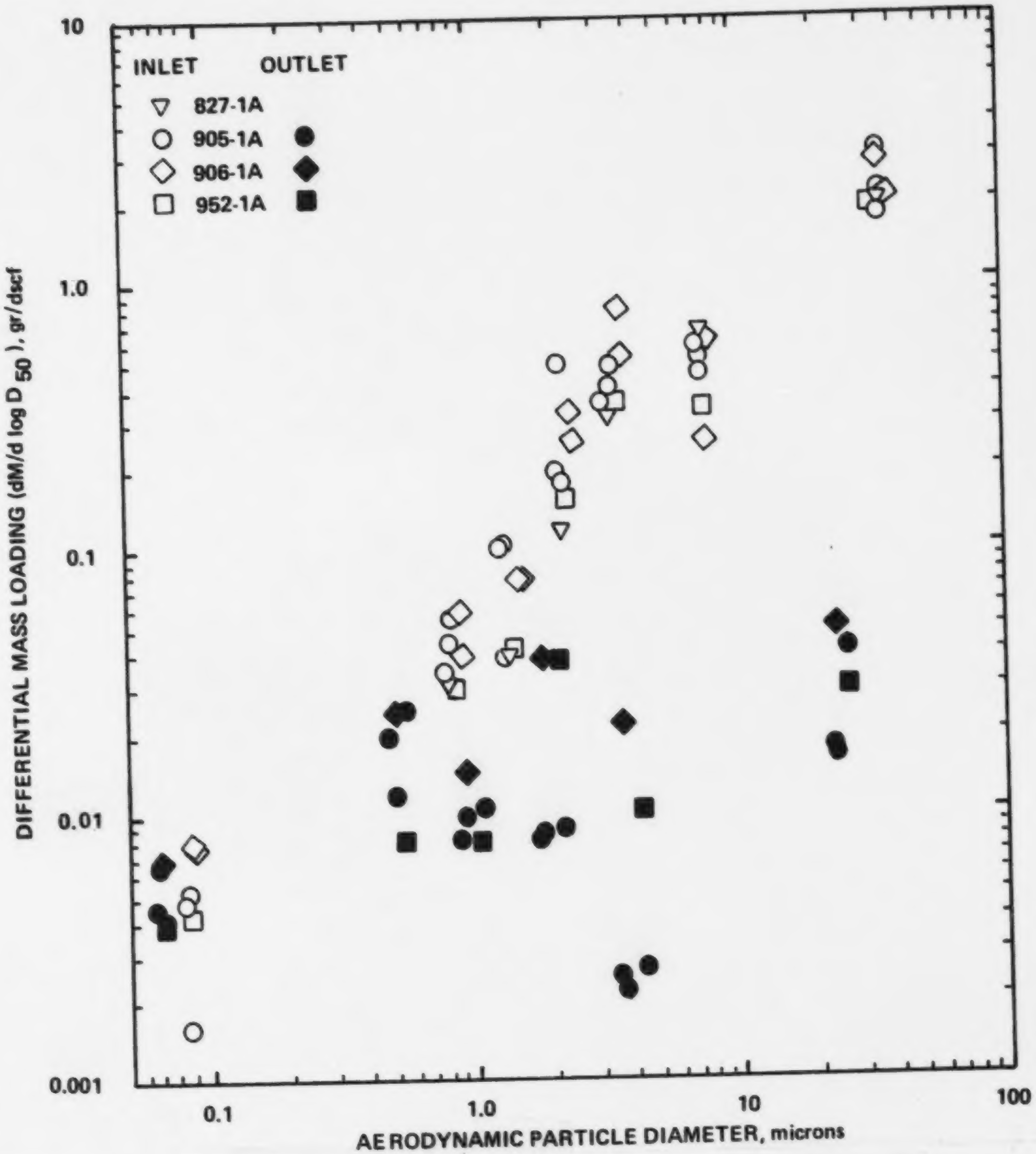

Figure M-1

Size Distributions for Venturi/Spray Tower Runs

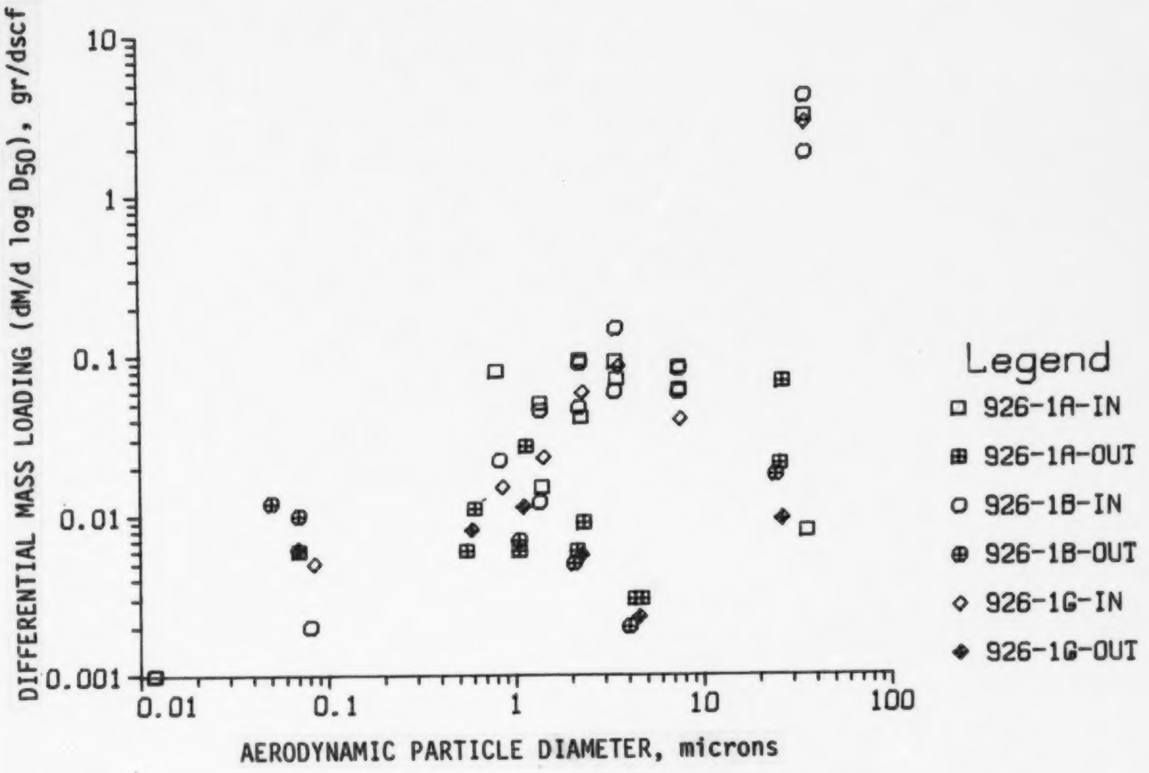

Figure M-2

Size Distributions for Venturi/Spray Tower Runs

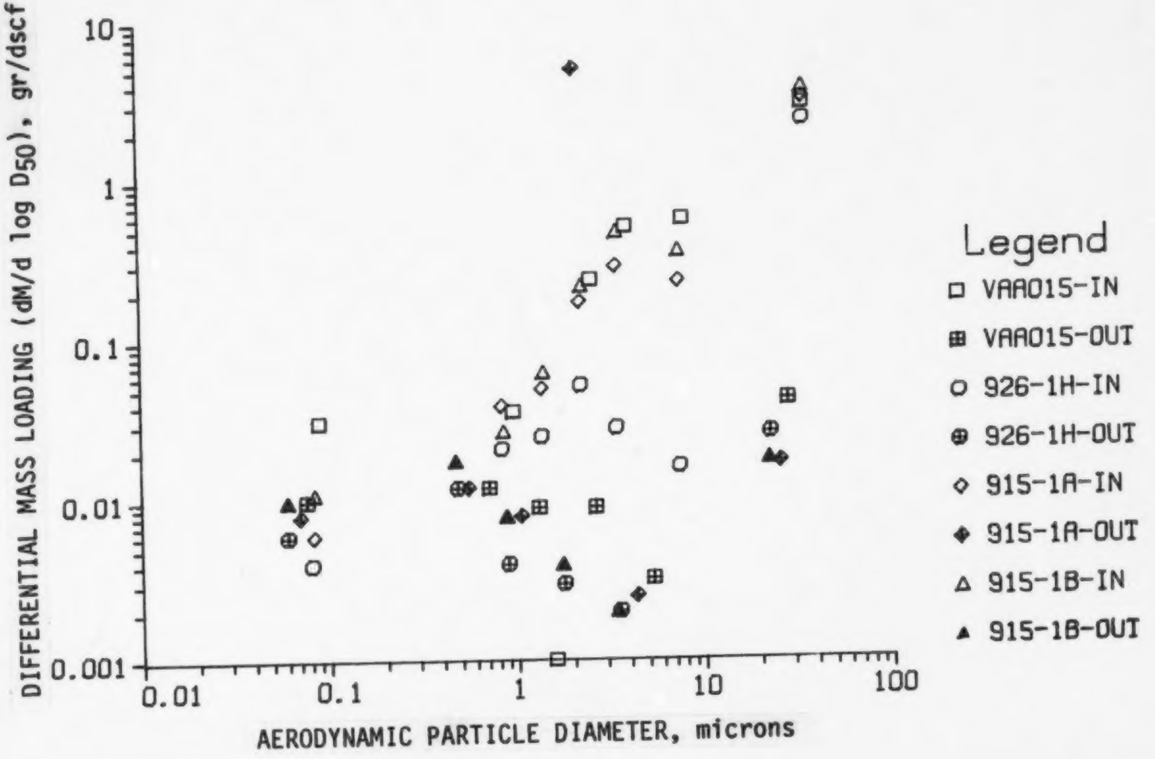

Figure M-3

Size Distributions for Venturi/Spray Tower Runs

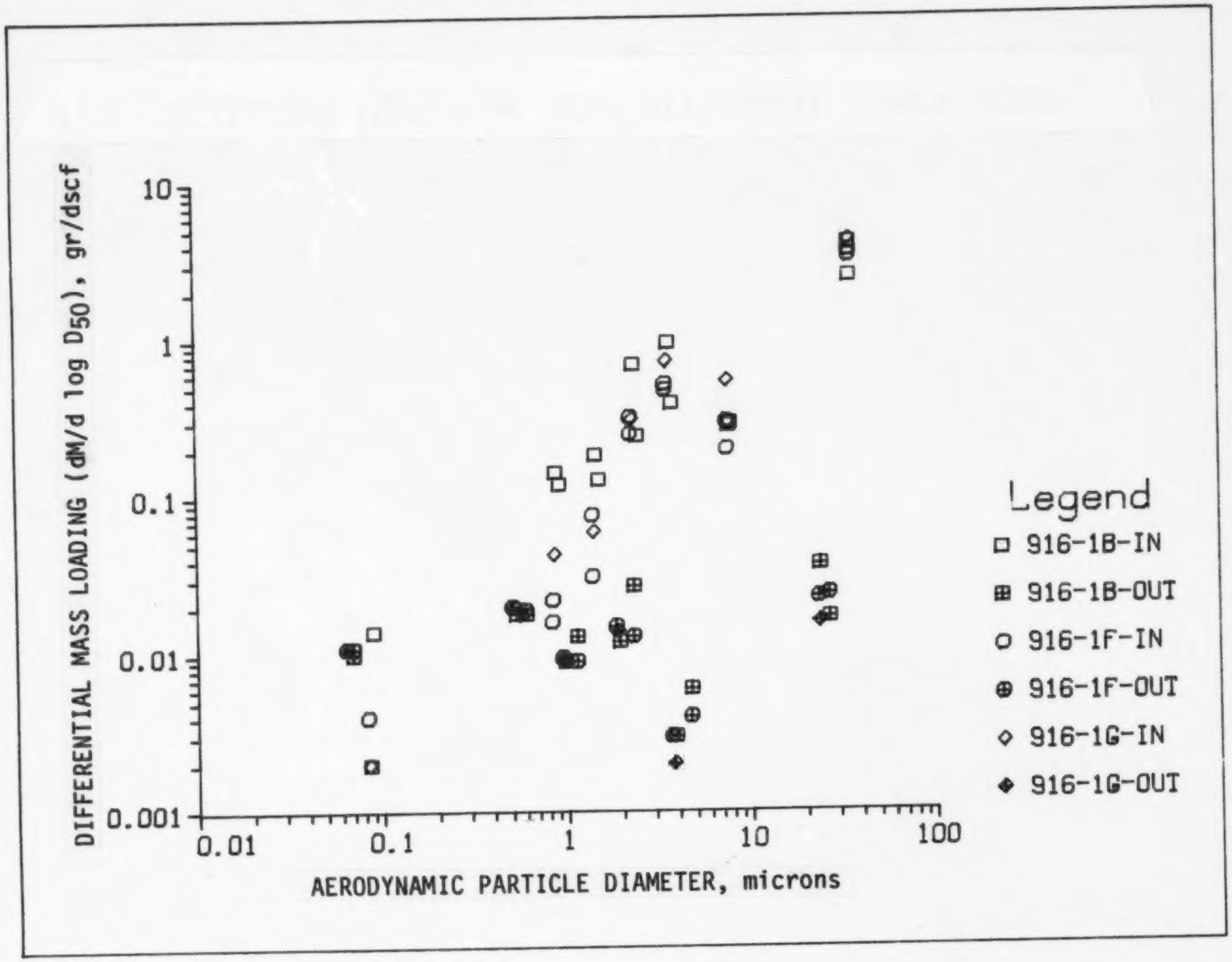

Figure M-4

Size Distributions for Venturi/Spray Tower Runs

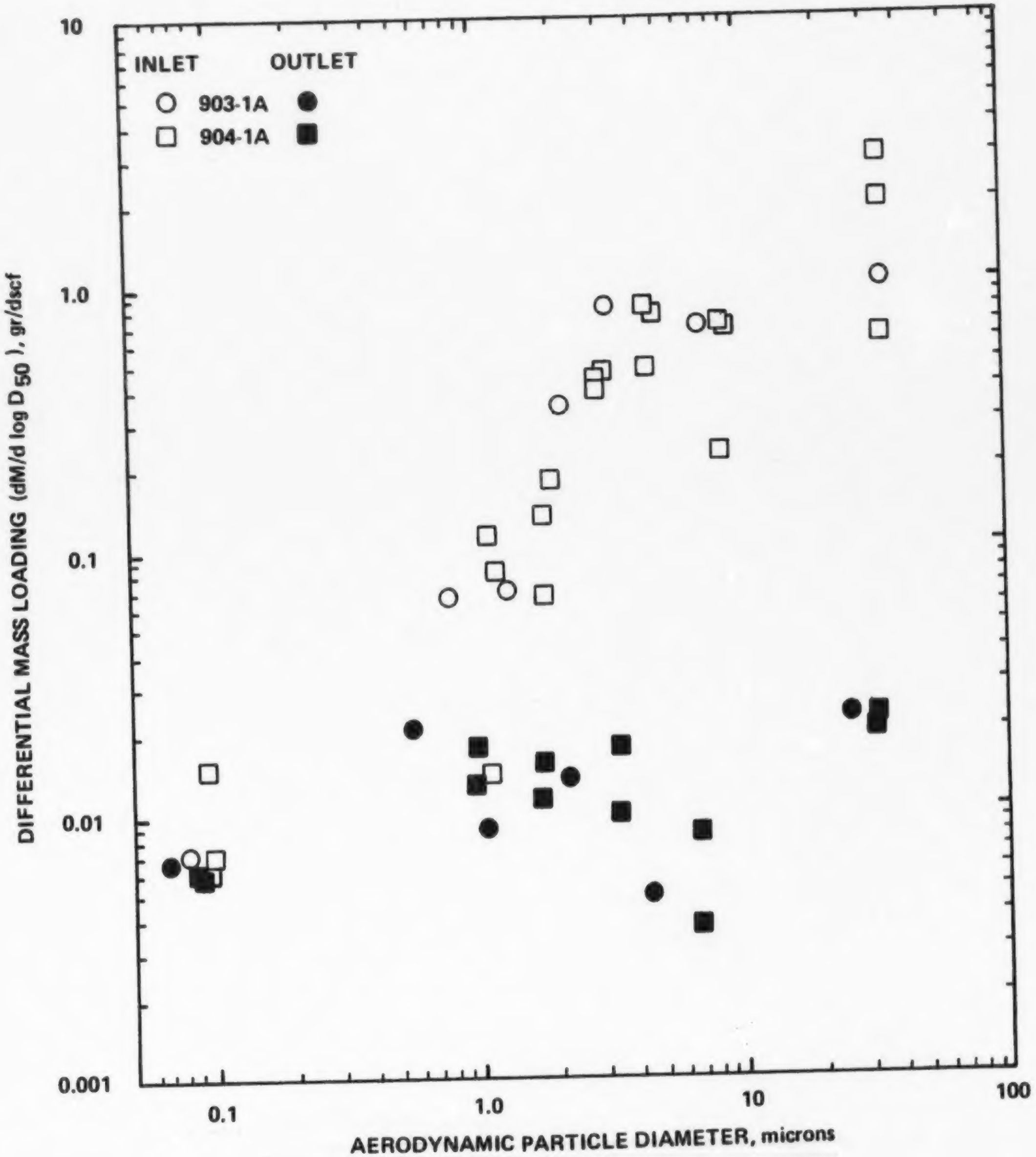

Figure M-5

Size Distributions for Venturi Only Runs

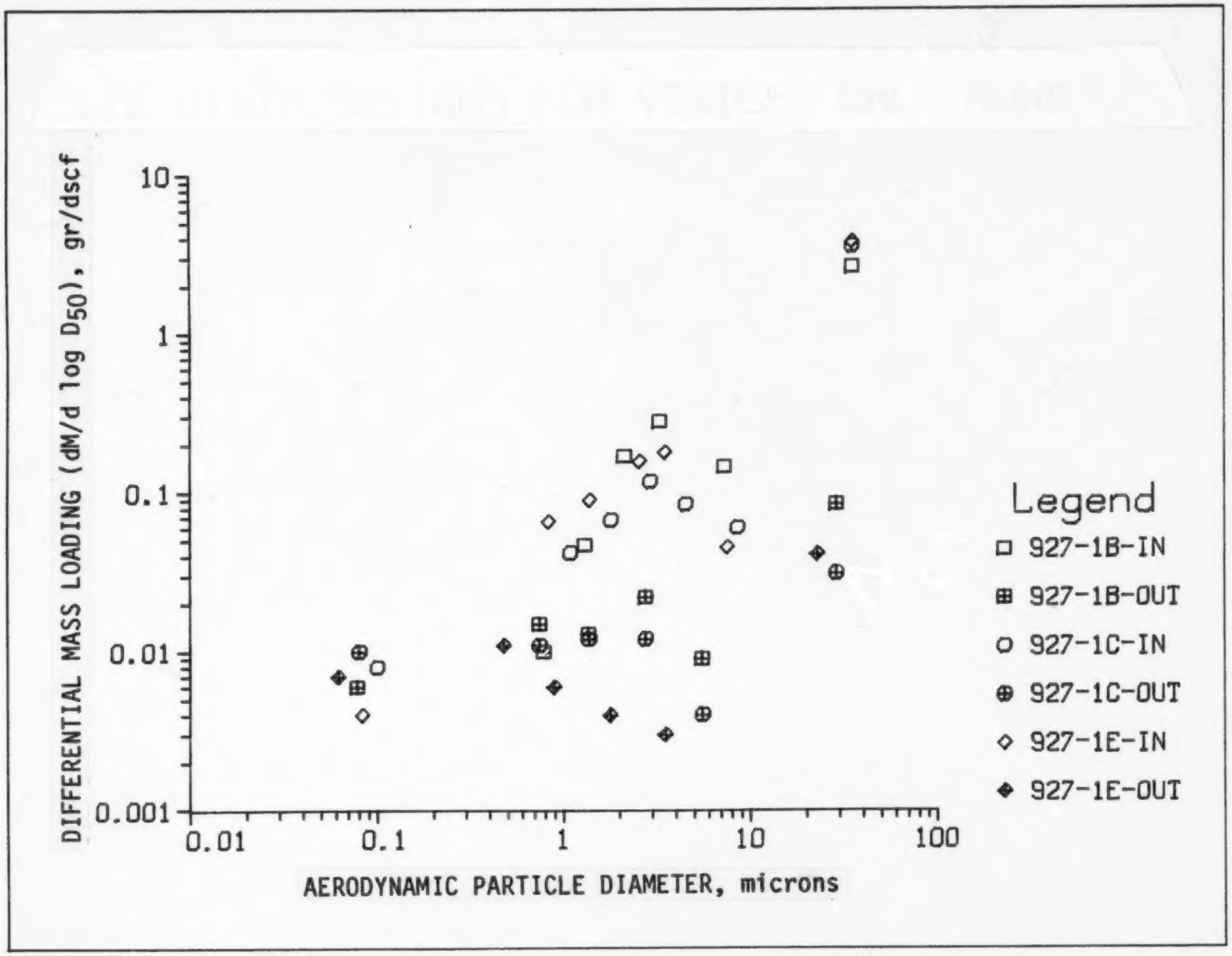

Figure M-6

Size Distributions for Venturi Only Runs

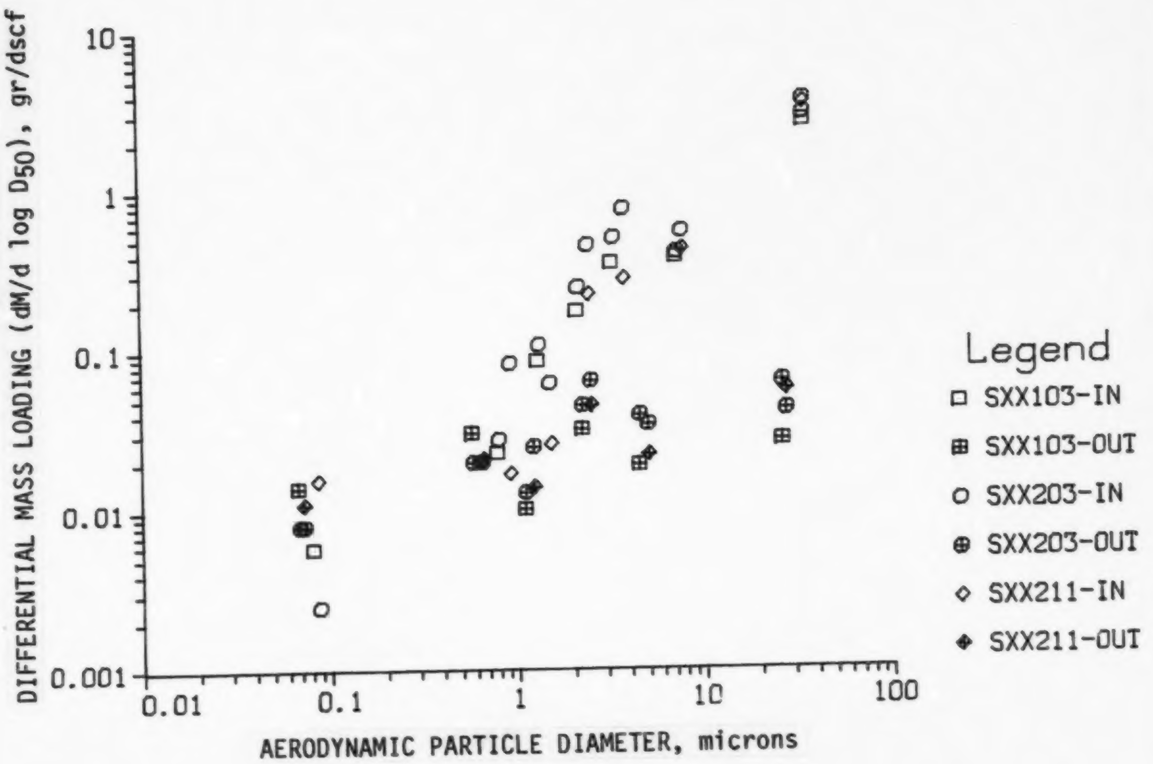

Figure M-7

Size Distributions for Spray Tower Runs

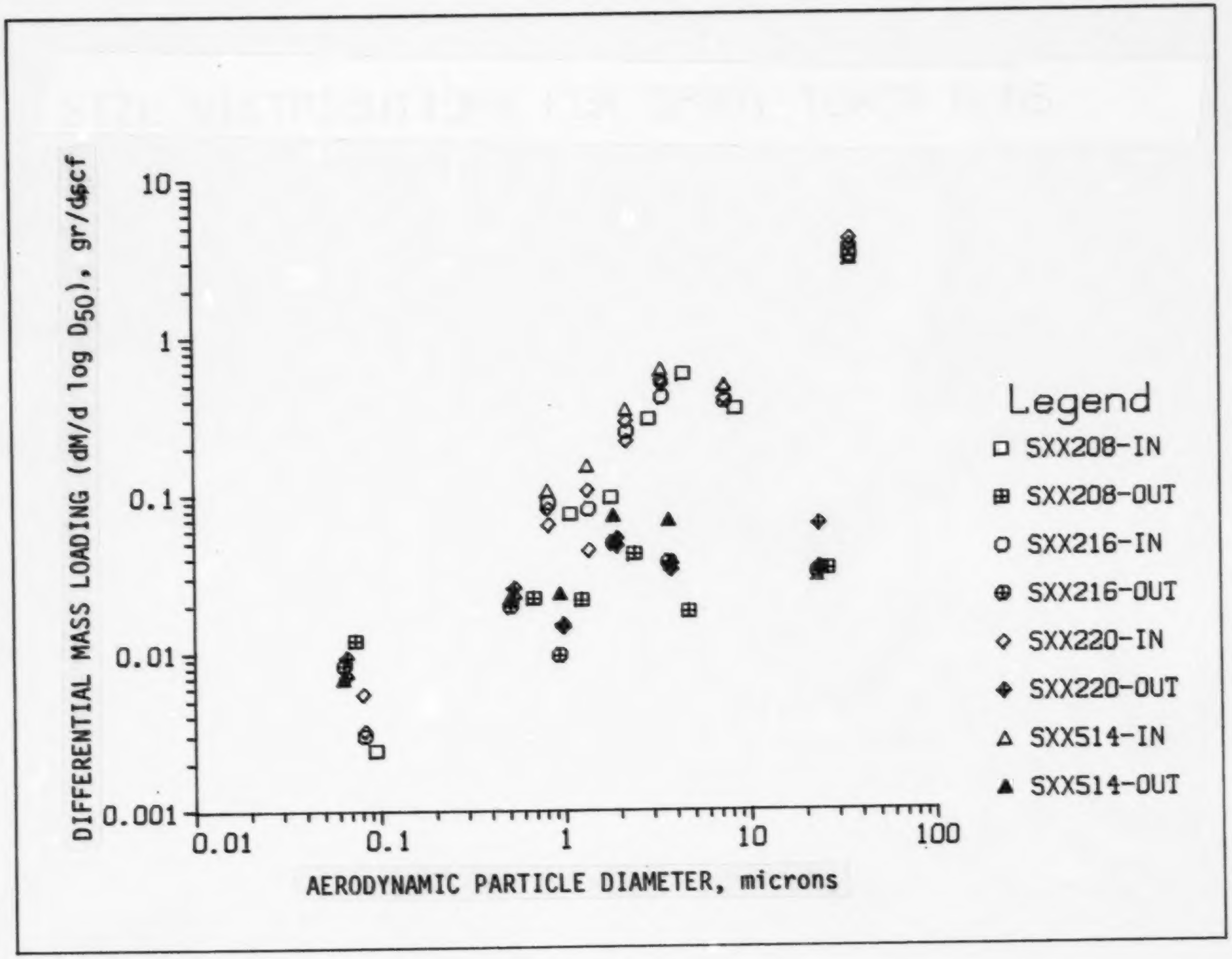

Figure M-8

Size Distributions for Spray Tower Runs

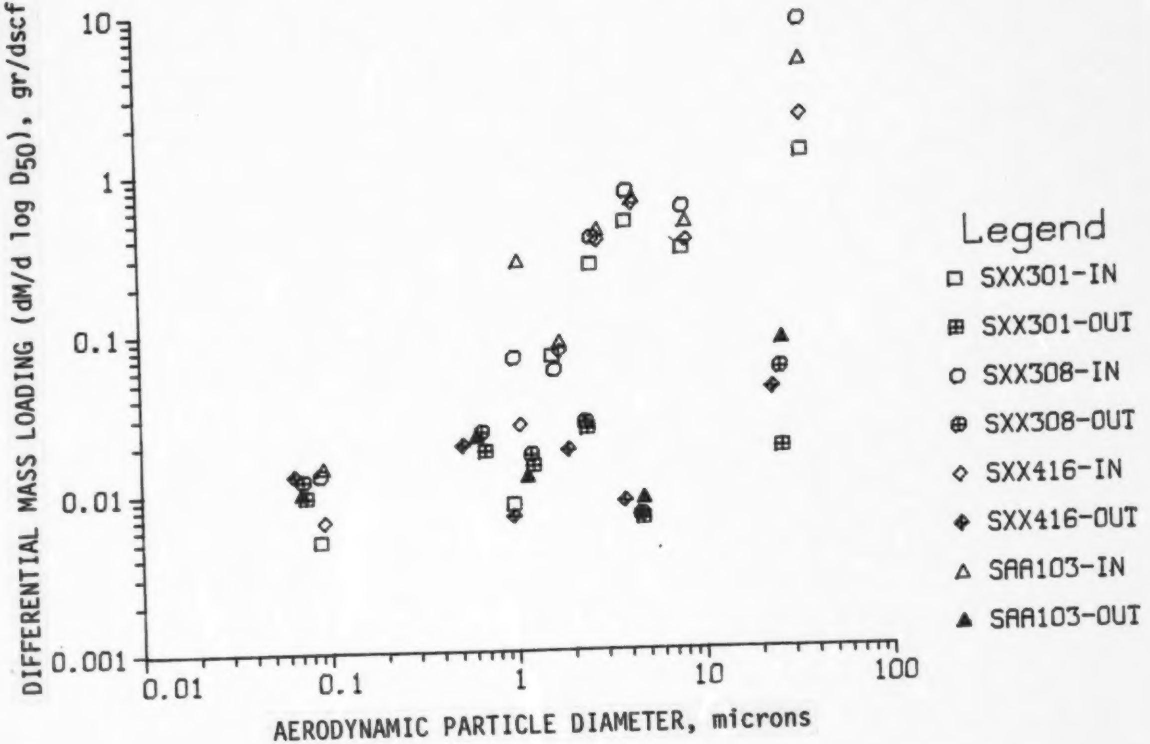

Figure M-9

Size Distributions for Spray Tower Runs

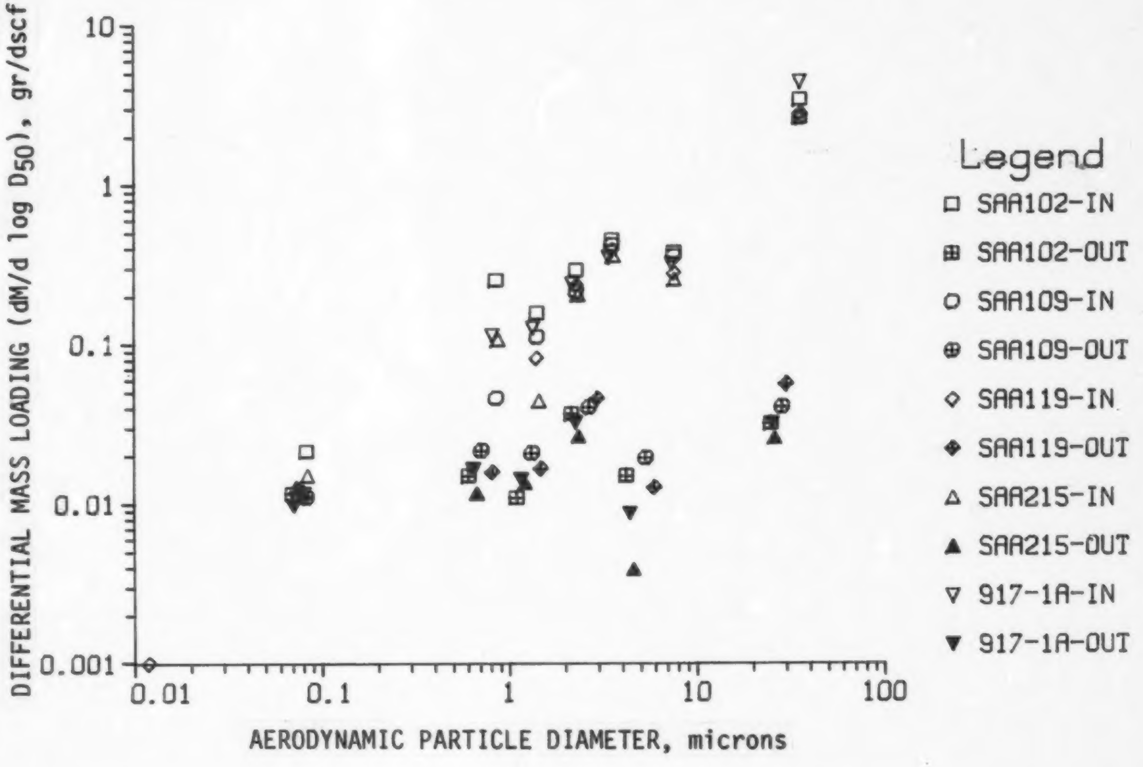

Figure M-10

Size Distributions for Spray Tower Runs

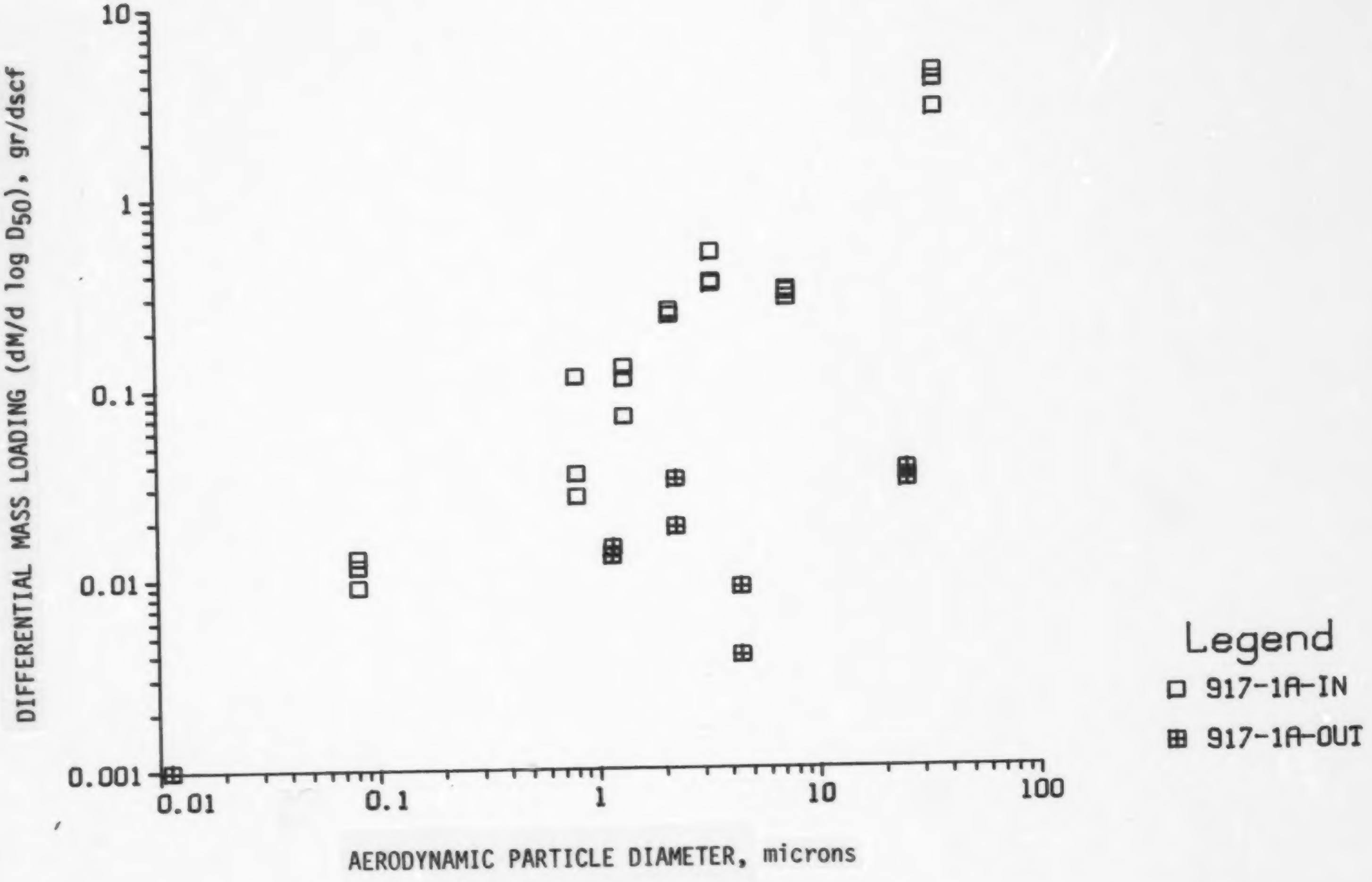

Figure M-11

Size Distributions for Spray Tower Runs

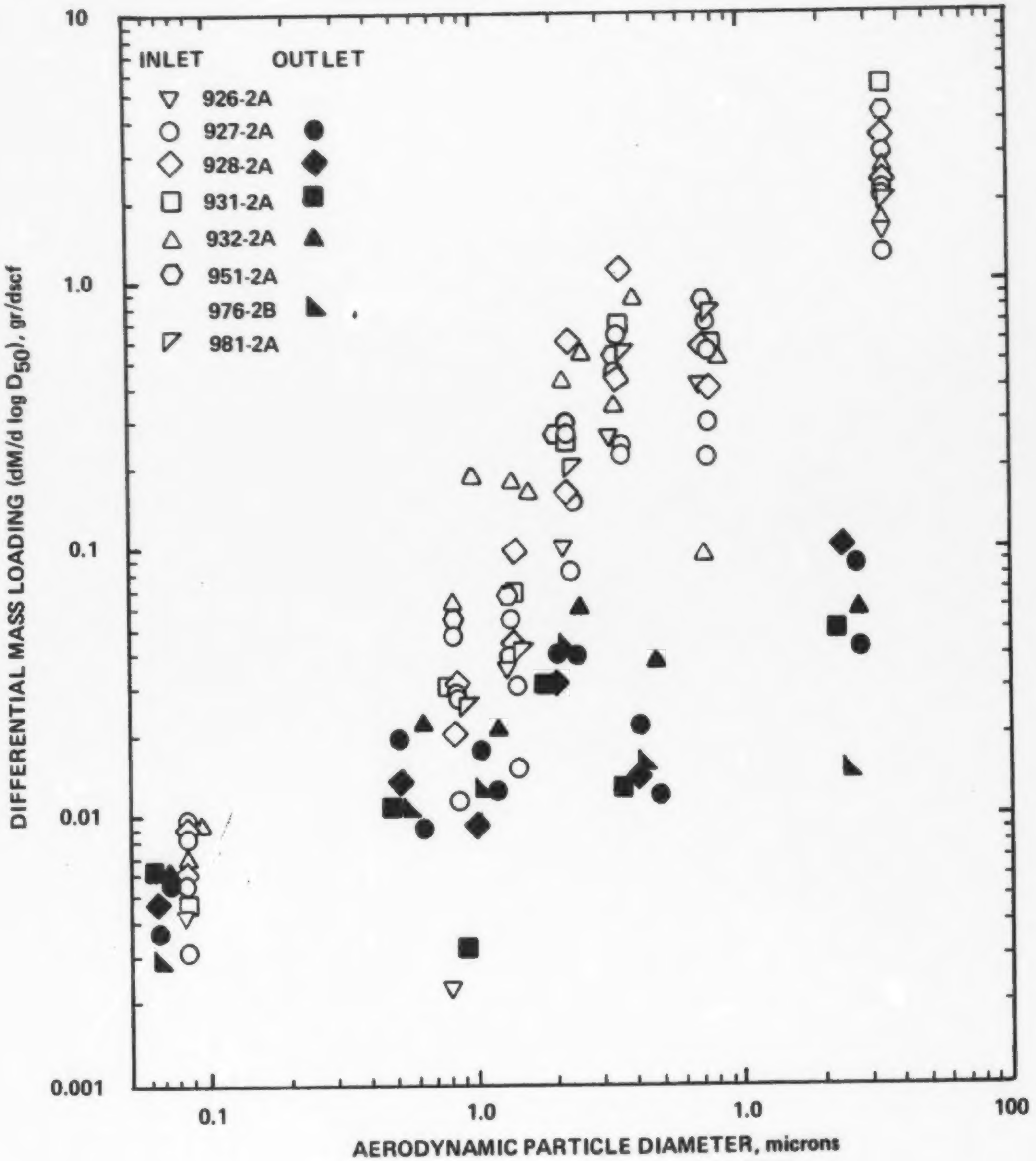

Figure M-12

Size Distributions for TCA Runs

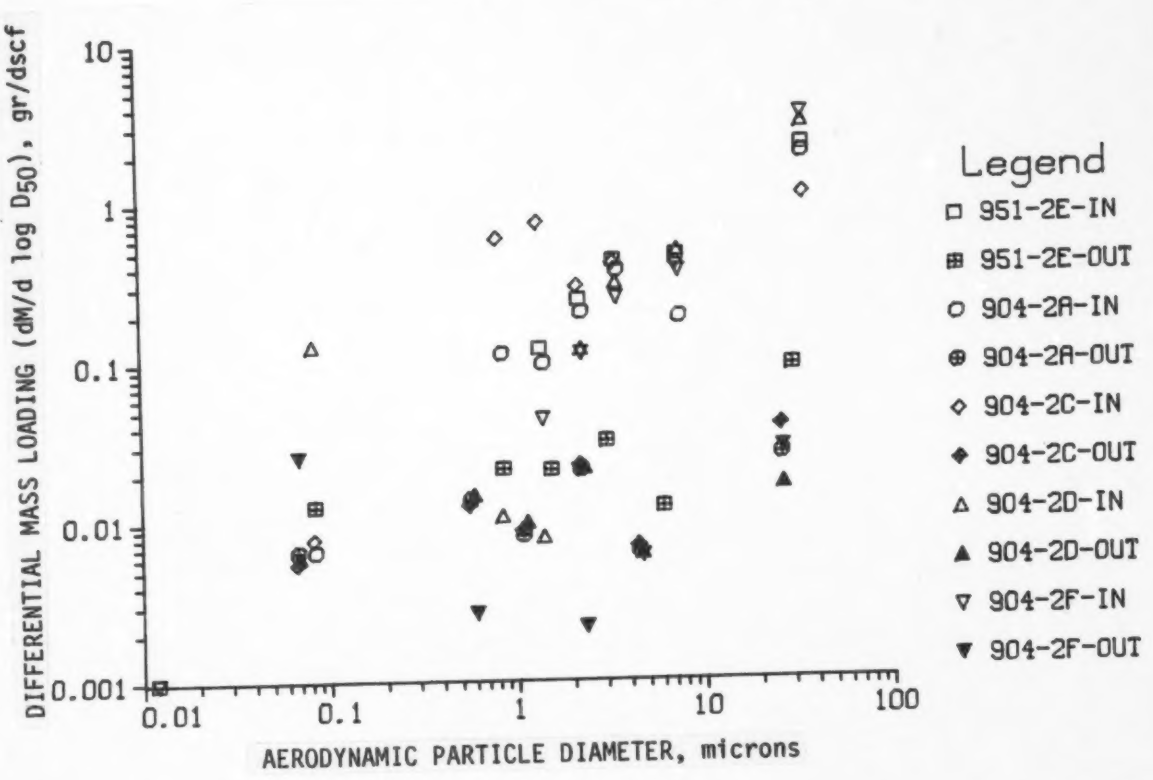

Figure M-13

Size Distributions for TCA Runs

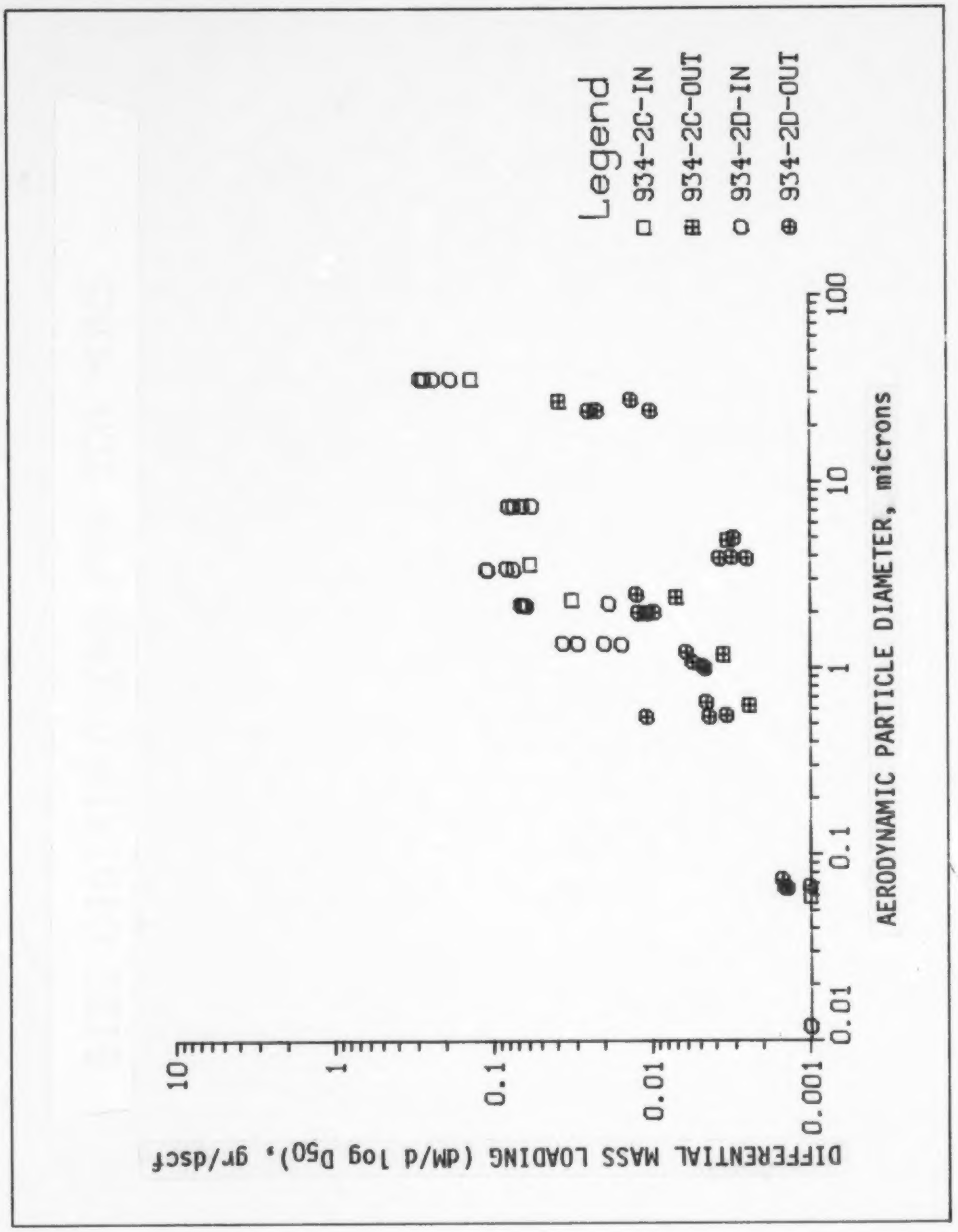

Figure M-14

Size Distributions for TCA Runs

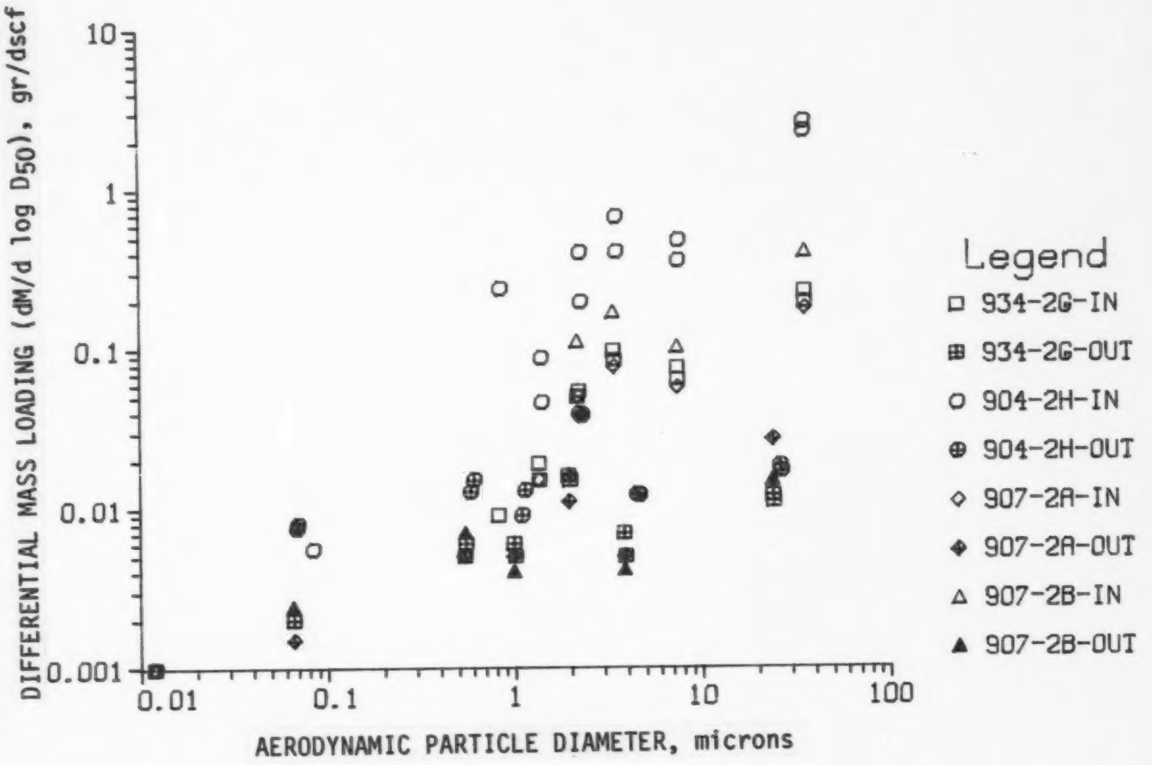

Figure M-15

Size Distributions for TCA Runs

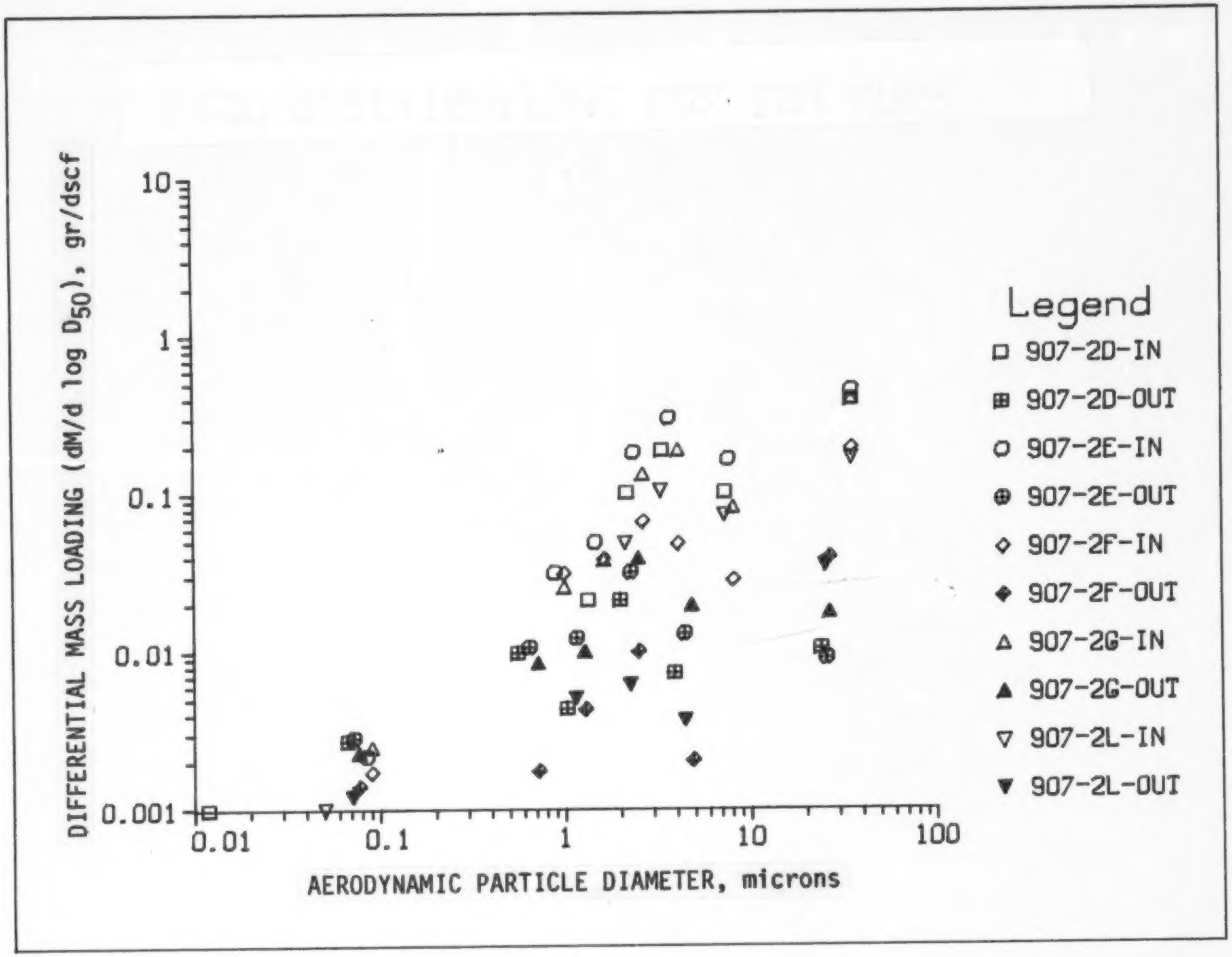

Figure M-16

Size Distributions for TCA Runs

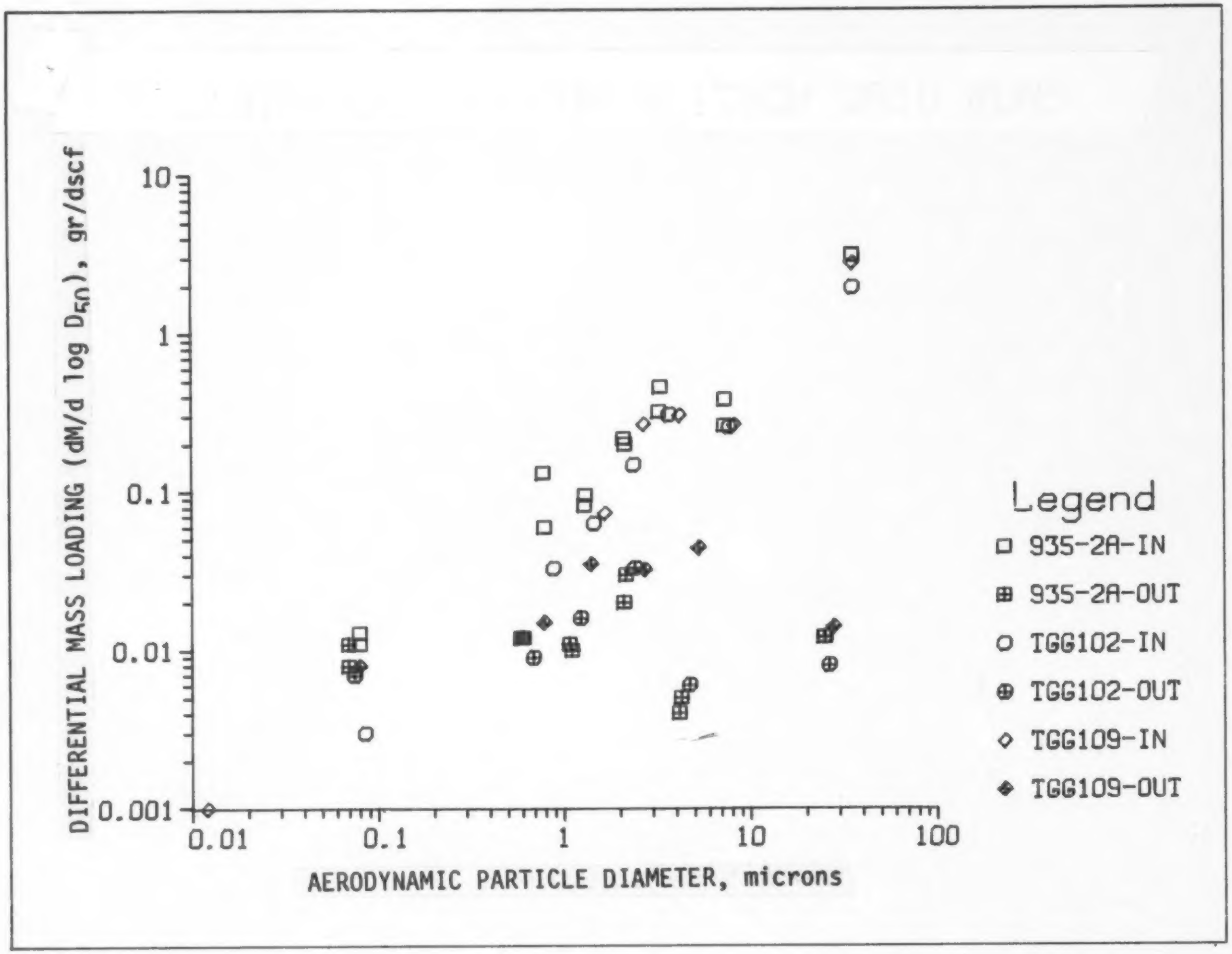

Figure M-17

Size Distributions for Glitsch Grid Packing Runs

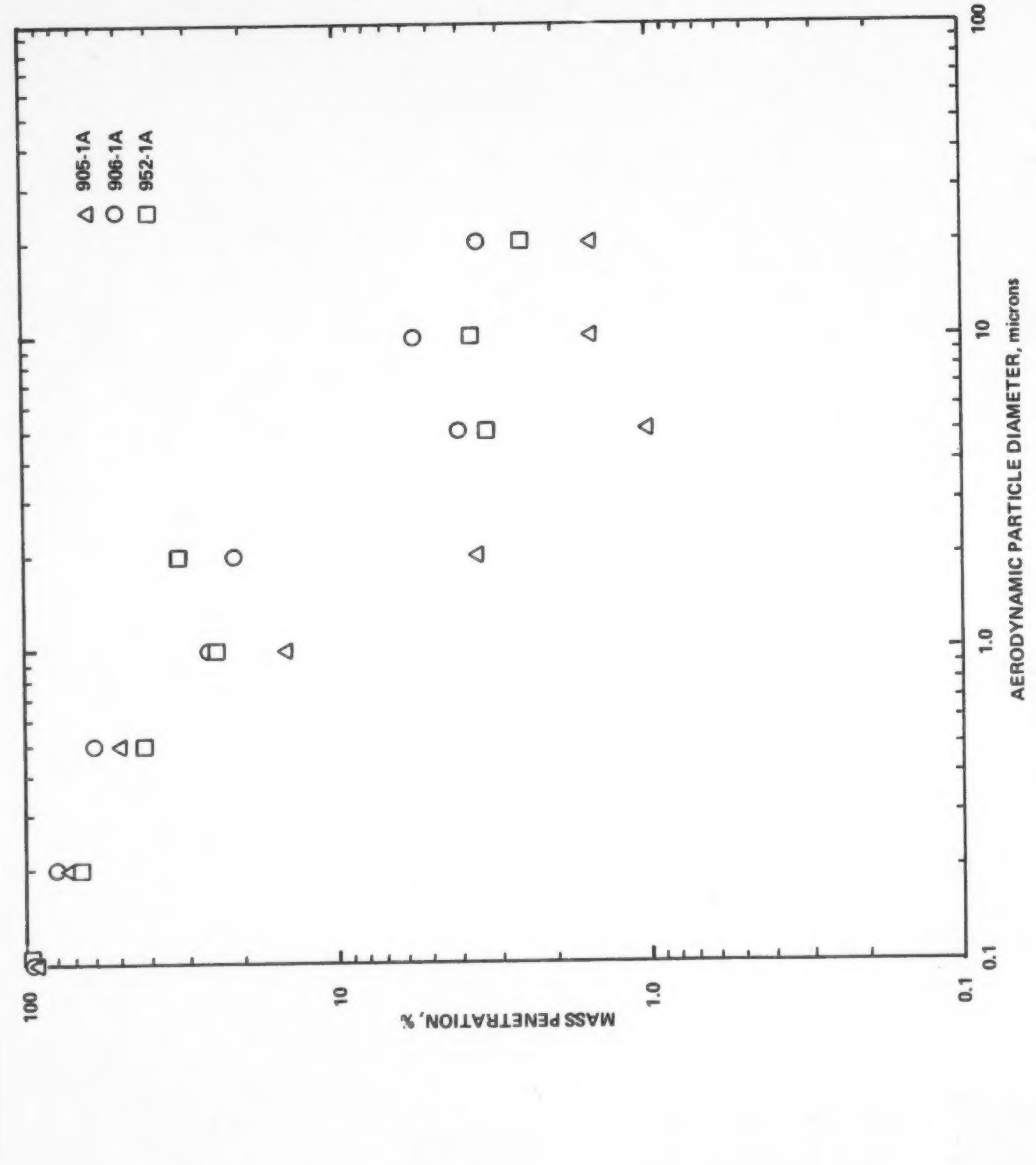

Figure M-18

Mass Penetrations for Venturi/Spray Tower Runs

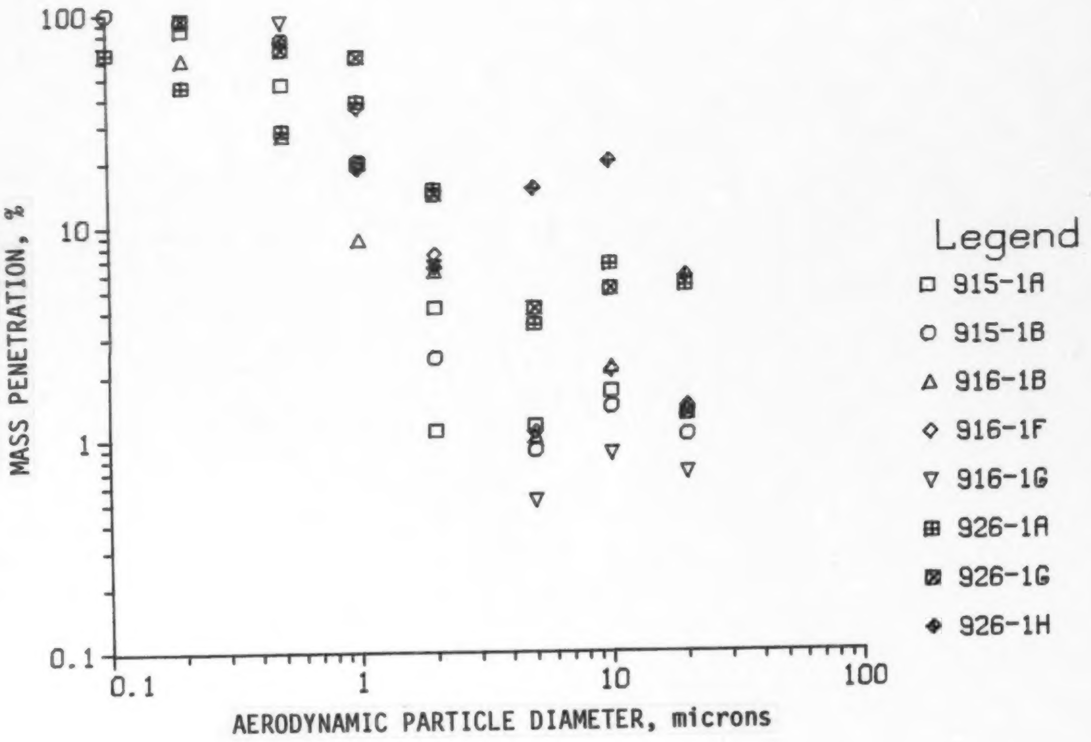

Figure M-19

Mass Penetrations for Venturi/Spray Tower Runs

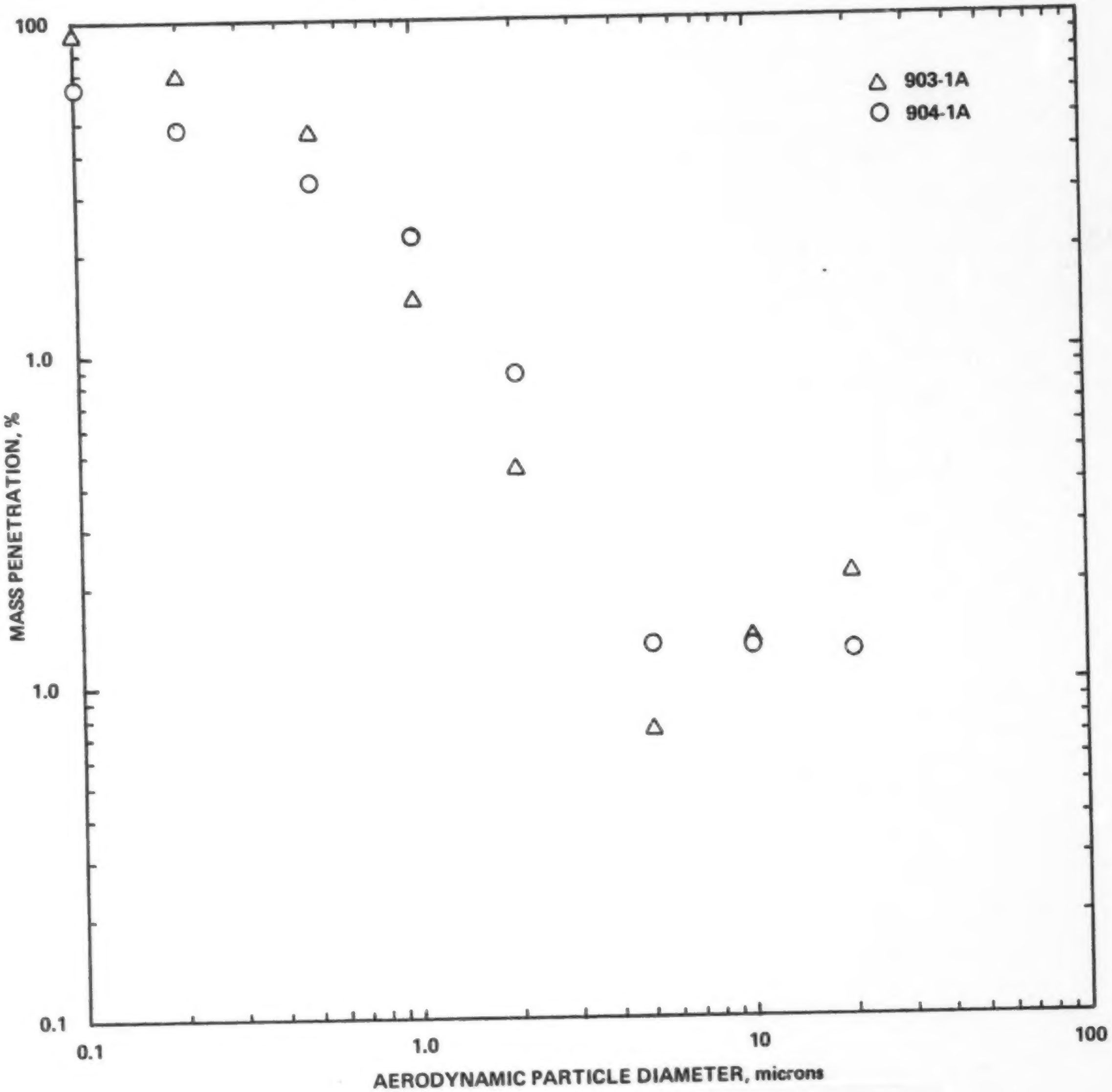

Figure M-20

Mass Penetrations for Venturi Only Runs

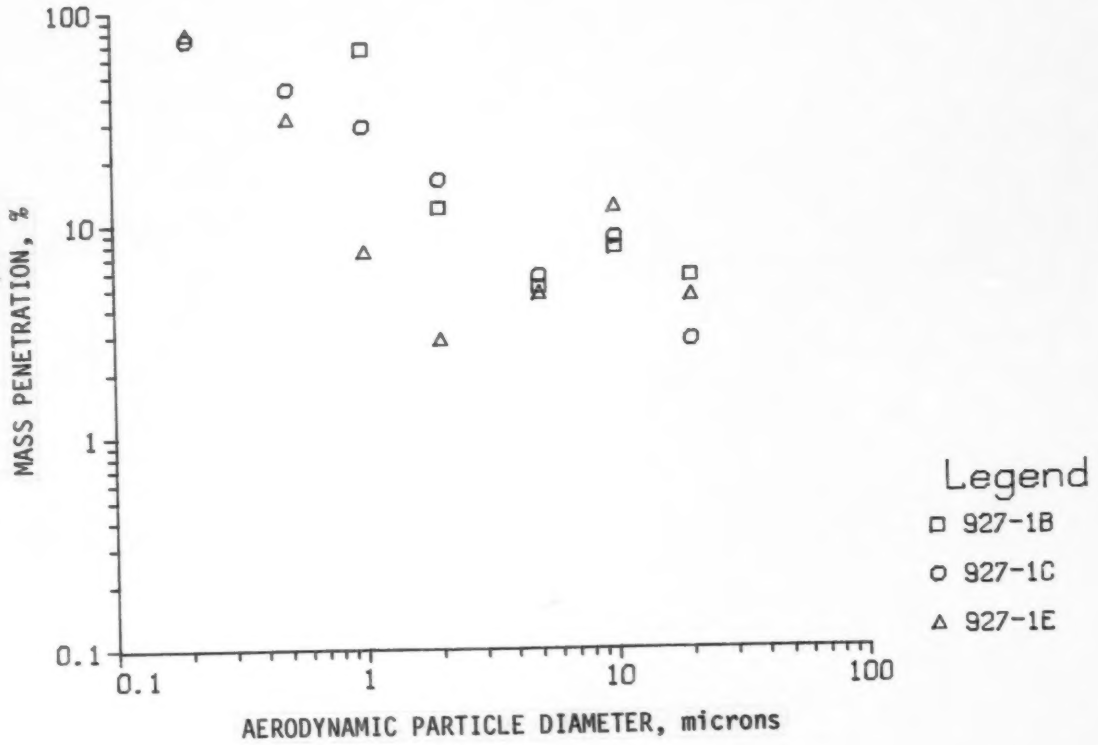

Figure M-21

Mass Penetrations for Venturi Only Runs

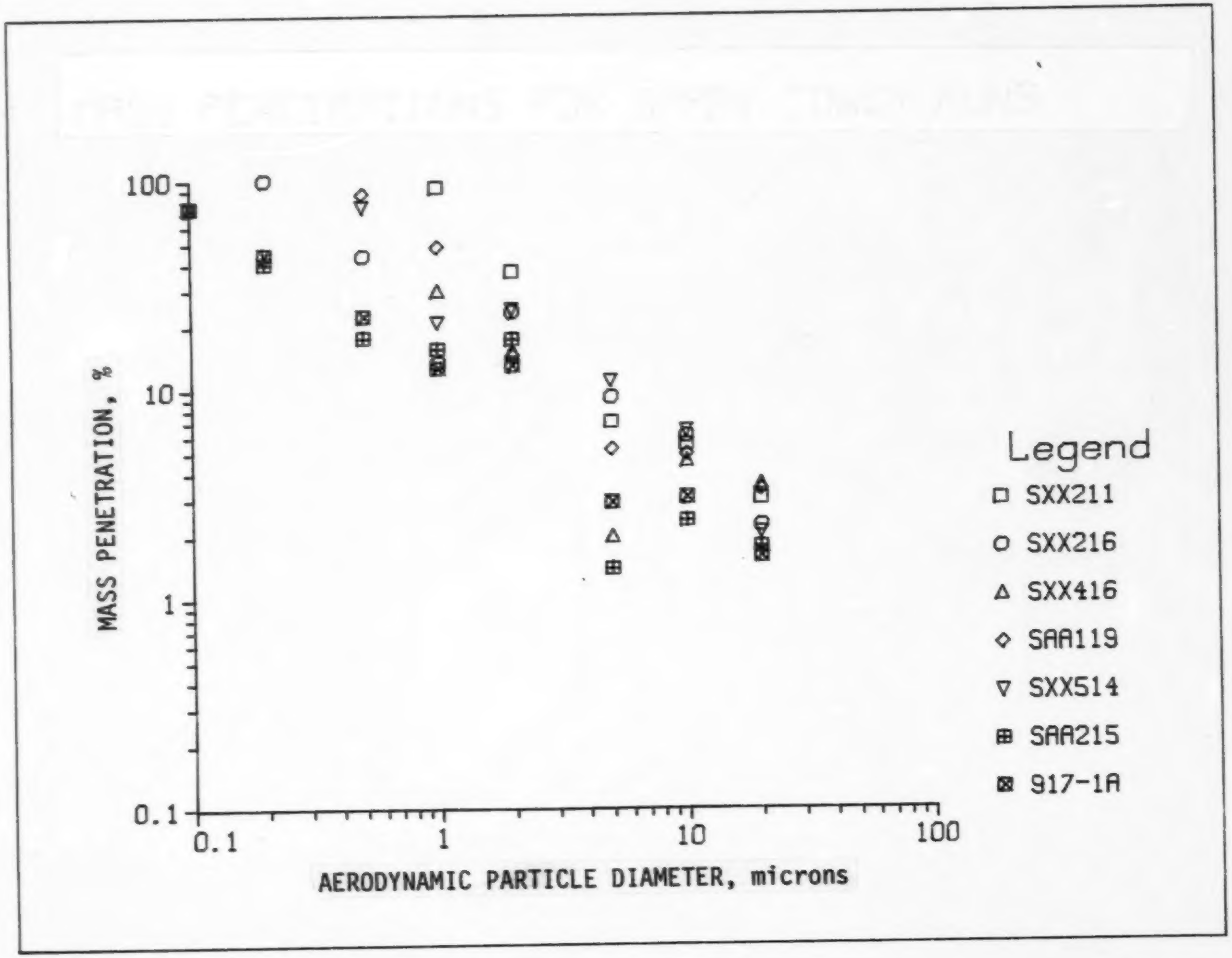

Figure M-22

Mass Penetrations for Spray Tower Runs

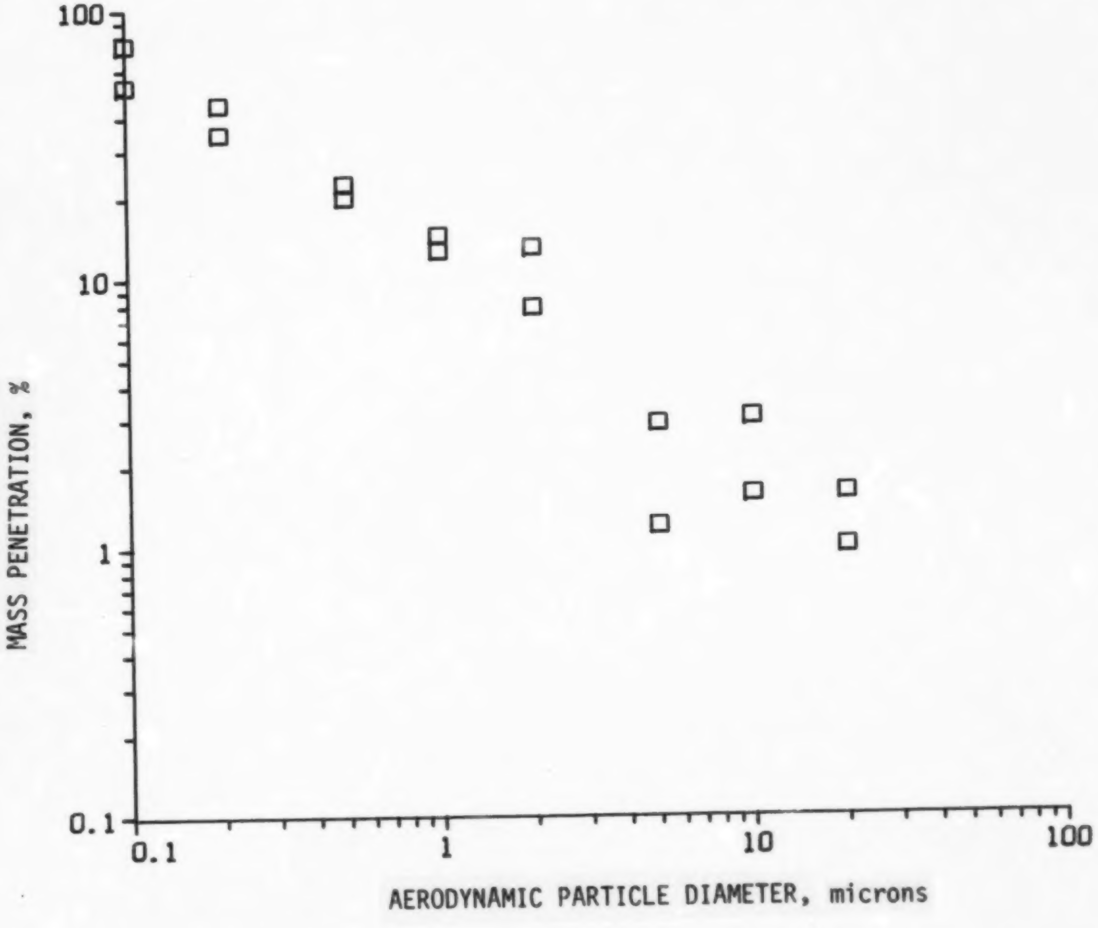

Figure M-23

Mass Penetrations for Spray Tower Run 917-1A

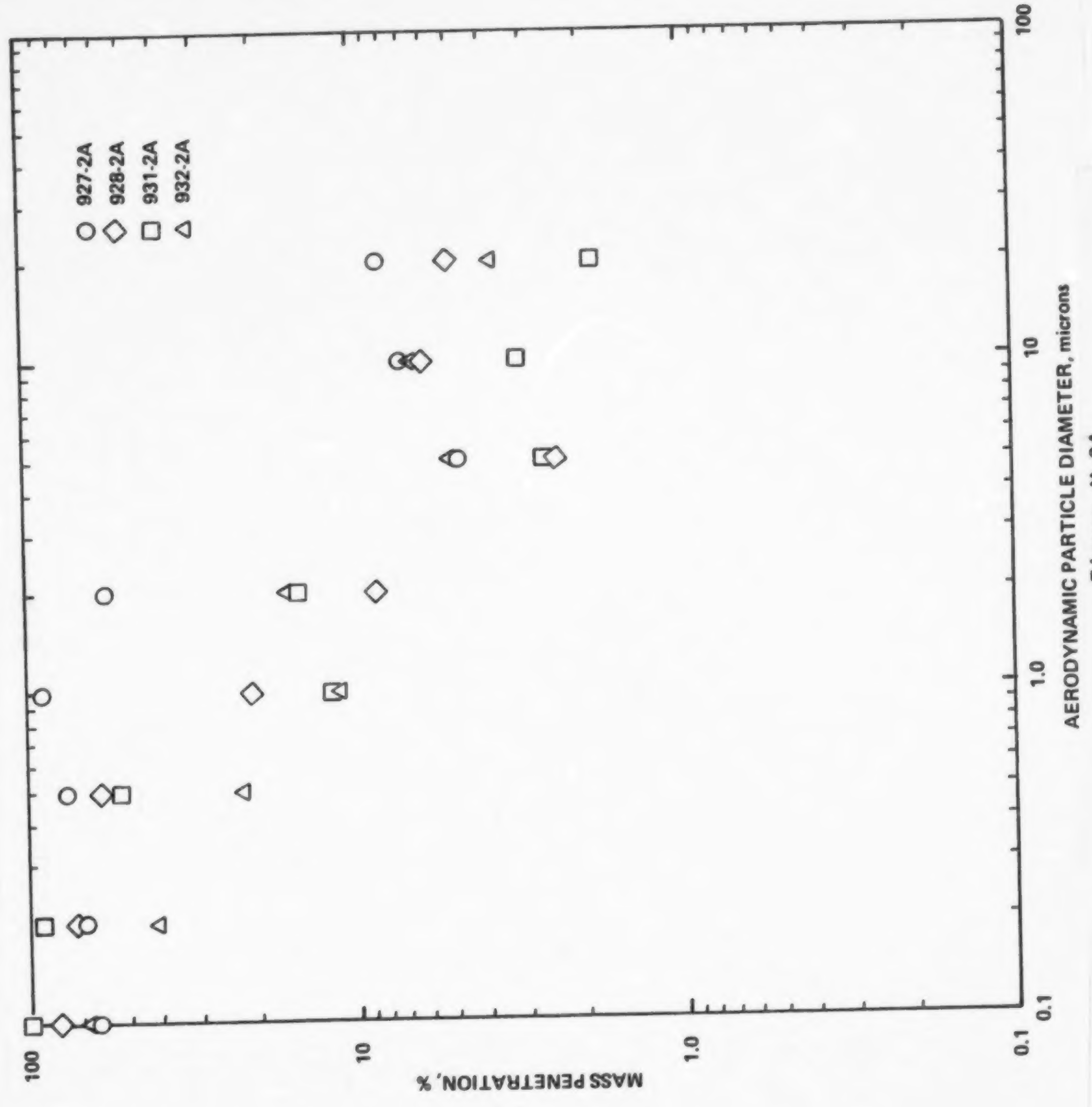

Figure M-24

Mass Penetrations for TCA Runs

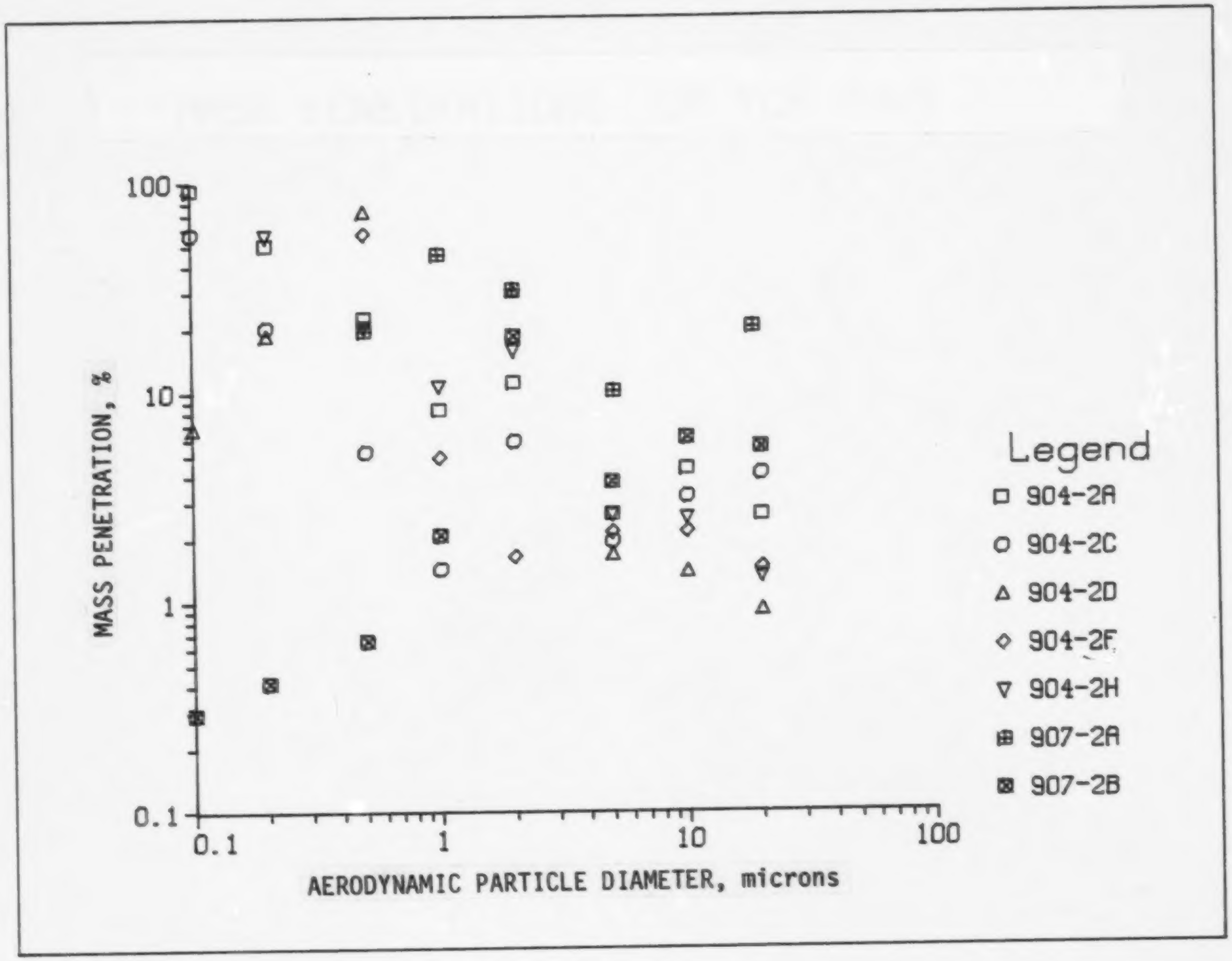

Figure M-25

Mass Penetrations for TCA Runs

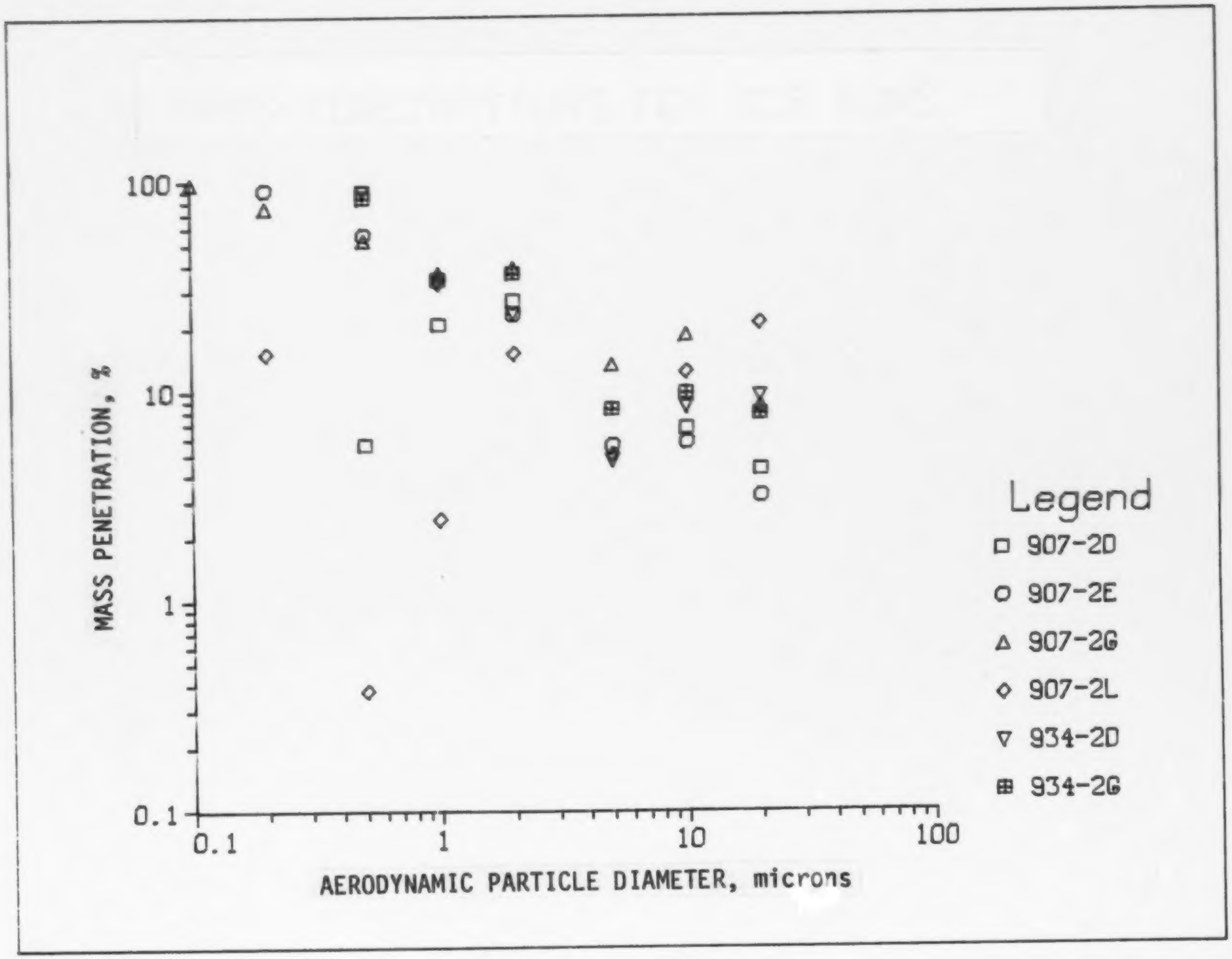

Figure M-26

Mass Penetrations for TCA Runs

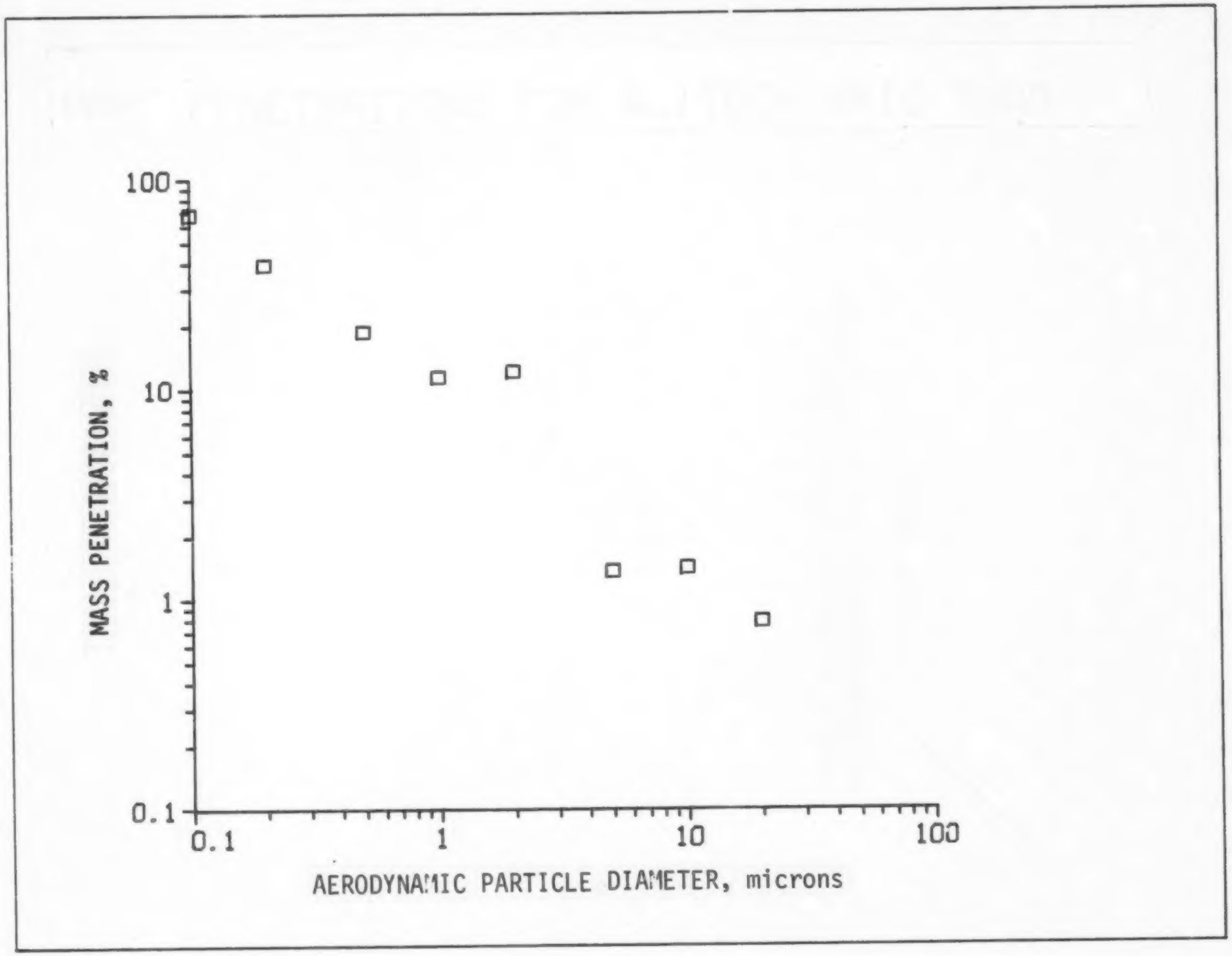

Figure M-27

Mass Penetrations for Glitsch Grid Packing Runs

APPENDIX N

ANALYTICAL METHOD FOR DETERMINATION OF TOTAL CARBOXYLIC ACID IN LIQUOR

Appendix N

ANALYTICAL METHOD FOR DETERMINATION OF TOTAL CARBOXYLIC ACID IN LIQUOR

This method is listed in the Laboratory Procedures Manual for the Shawnee Test Facility (Reference 13).

1. Scope

This method is used for measuring short chain organic acids including adipic acid in scrubber liquor. It is used for routine control of adipic acid concentration in scrubber slurry.

2. Summary of Method

Filtered slurry liquor is acidified and then absorbed on silicic acid. Organic acids are eluted with butanol in chloroform. The eluent is then titrated with standard alcoholic base. Results are calculated as adipic acid.

3. Interferences

Organic acid breakdown products of adipic acid such as glutaric acid, valeric acid, and succinic acid will be included in this determination.

Only organic acids dissolved in the slurry will be measured. Organic acids occluded in the solids will not be measured.

4. Special Apparatus

a. Millipore filter apparatus for 47 mm filters

b. Membrane filter disks, 8 μm pore size, 47 mm diameter

c. Carboy, plastic, 5 gallon with spigot

d. Separatory funnel, 1 liter

e. Graduated cylinder, 2000 ml

f. pH meter with electrodes

g. Compressed nitrogen with regulator, valve, and hose

5. Reagents

a. Sulfuric acid, H_2SO_4, concentrated

b. Sulfuric acid, H_2SO_4, dilute

Carefully pour 20 ml of conc H_2SO_4 into 1600 ml of deionized water in a 2000 ml graduated cylinder while mixing.

c. Chloroform--butanol reagent

Transfer 6000 ml of chloroform to a 5 gallon carboy. Add 2000 ml of n-butanol. Add the dilute sulfuric acid prepared in 5b. Cap carboy and shake to mix thoroughly. Let the mixture stand for 15 to 20 minutes. Drain the organic layer from spigot through an 8 μm Millipore filter into a dry filter flask. Each time the flask fills, transfer filtrate to a dry, labeled bottle. When water starts to appear in the filtrate, transfer the filtrate and the liquid remaining the the carboy to a separatory funnel, and transfer the bottom, organic phase in the separatory funnel to the 8 μm filter. The reagent which is stored must contain no water.

d. Sodium hydroxide, NaOH, standard, 0.0195N

Pipet 20.0 ml of standard 0.9738N NaOH into a 1 liter volumetric flask. Dilute to the mark with absolute methanol and mix.

e. Silicic acid, chromatography grade

f. Phenophthalein indicator solution, 0.5%

Dissolve 5 g of phenolphthalein in about 750 ml of isopropanol in a 1-liter volumetric flask. Dilute to volume with isopropanol and mix.

g. Hydrochloric acid, HCl, 0.05N

Dilute a 1N HCl "Dilut-it" ampoule to volume in a 1 liter volumetric flask. Mix. Pipet 50.0 ml of the solution into a 1 liter volumetric flask. Dilute to volume and mix.

6. Procedure

6.1 Slurry Liquor

a. Filter about 200 ml of a slurry through an 8 μm Millipore filter into a clean, dry filter flask.

b. Transfer 25 to 30 ml of the filtrate (slurry liquor) to a beaker.

c. Acidify with conc H_2SO_4, to a pH between 1.0 and 1.2 using a pH meter. No more than 10 drops of acid should be required.

d. Place approximately 18 g of silicic acid in a clean, dry Millipore funnel. Apply vacuum and tap funnel until the silicic acid has settled. Remove vacuum.

NOTE: Always use a new silicic acid column for each sample.

e. Pipet 5.00 ml of acidified sample onto the center of the silicic acid column. Be careful that none of the sample contacts the funnel walls.

f. Apply vacuum then add 70 to 75 ml of chloroform-butanol reagent to the sample. Discontinue the suction just before the last of the reagent enters the column.

g. Purge the eluted sample with nitrogen for about 10 minutes. Avoid spattering caused by purging too rapidly.

h. Add 4 drops of phenolphthalein indicator to the scrubbed extract.

i. Titrate the solution with standard NaOH while maintaining a nitrogen blanket over the sample. Solution will change from colorless to pink at the endpoint. Record volume of NaOH used.

6.2 Blank

a. Place 2 to 30 ml of synthetic sample without adipic acid in a beaker.

b. Acidify with conc H_2SO_4 to a pH between 1.0 and 1.2 using a pH meter.

c. Repeat Steps d through i of 6.1

6.3 NaOH Standardization

a. Pipet 5.00 ml of 0.05N HCl into a 125-ml Erlenmeyer flask.

b. Add about 25 ml of deionized water and 4 drops of phenolphthalein.

c. Titrate with standard NaOH until solution just changes from clear to pink.

7. Calculations

7.1 Organic Acids

$$\text{Organic acids, ppm as adipic acid} = \frac{(S-B) \times N \times 73{,}000}{V}$$

where: S = volume of NaOH to titrate sample, ml

B = volume of NaOH to titrate blank, ml

N = normality of NaOH

73,000 = milliequivalent weight of adipic acid, mg/meq x 1000 ml/l

V = volume of sample used in Step 6.1e, ml

7.2 NaOH Standardization

$$\text{NaOH normality} = \frac{V_A \times V_A}{V_B}$$

where: V_A = volume of HCl used in Step 6.3a, ml

N_A = normality of HCl

V_B = volume of NaOH for titration in Step 6.3c, ml

8. Reference

Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, and WPCF, publishers 14th Edition, pp. 527-529 (1975).